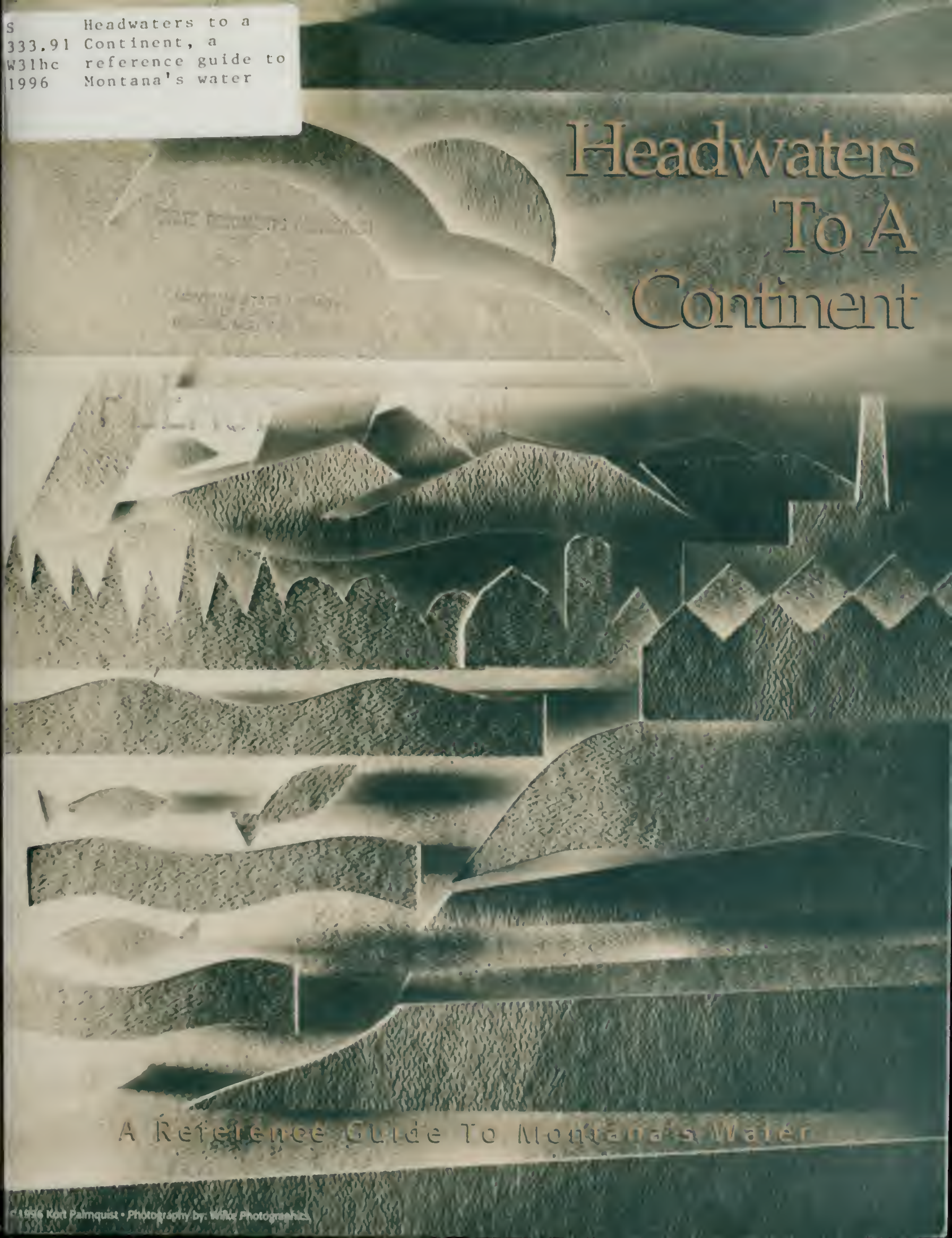
Headwaters To A Continent



A Reference Guide To Montana's Water

Headwaters To A Continent

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Preface

Montanans have long recognized water's importance to our lives and livelihood and to the Western landscape that draws us. People ask questions and raise concerns about Montana's water at workshops, meetings, and hearings around the state. Citizens have made it clear that they want basic, unbiased information to help them make informed water management decisions. Teachers and students want to learn the facts about water for special research papers and classroom projects. Landowners look for tips about how to manage water use on private property. City dwellers want facts about the quality and sources of their municipal supplies.

Motivated by these and many other needs, Montana's Water Development Grant Fund provided money for the Montana Watercourse to develop this compendium of water facts. It is intended to contribute to a thoughtful vision of Montana's water future.

The guide reviews:

- ✔ *The hydrologic cycle, the history of water use in Montana, and water availability.*
- ✔ *Water use, including information about who uses water and how they use it.*
- ✔ *The quality of the state's surface and ground water.*
- ✔ *Profiles of the Yellowstone, Missouri, and Columbia river basins.*
- ✔ *Water management responsibilities of federal, state, and regional agencies.*
- ✔ *And, most importantly, ways you can become involved in local water management in your watershed.*

You'll find information from many sources, arranged so that a broad audience—from sixth graders preparing reports to land managers seeking technical assistance—can find what they need. We have highlighted key facts, italicized important terms the first time they appear in the text, defined terms in the glossary, provided details in sidebars and tables, and included resources at the end of each chapter and the book that point you to more information. We've also included a center section of maps, and further illuminated the text with historic and contemporary photographs, charts, and drawings—all to make this guide as accessible as possible to a variety of users.

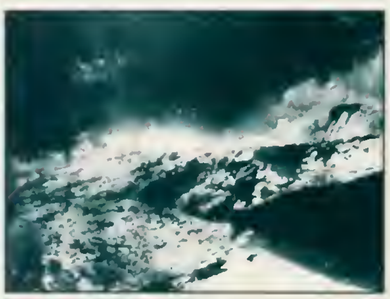


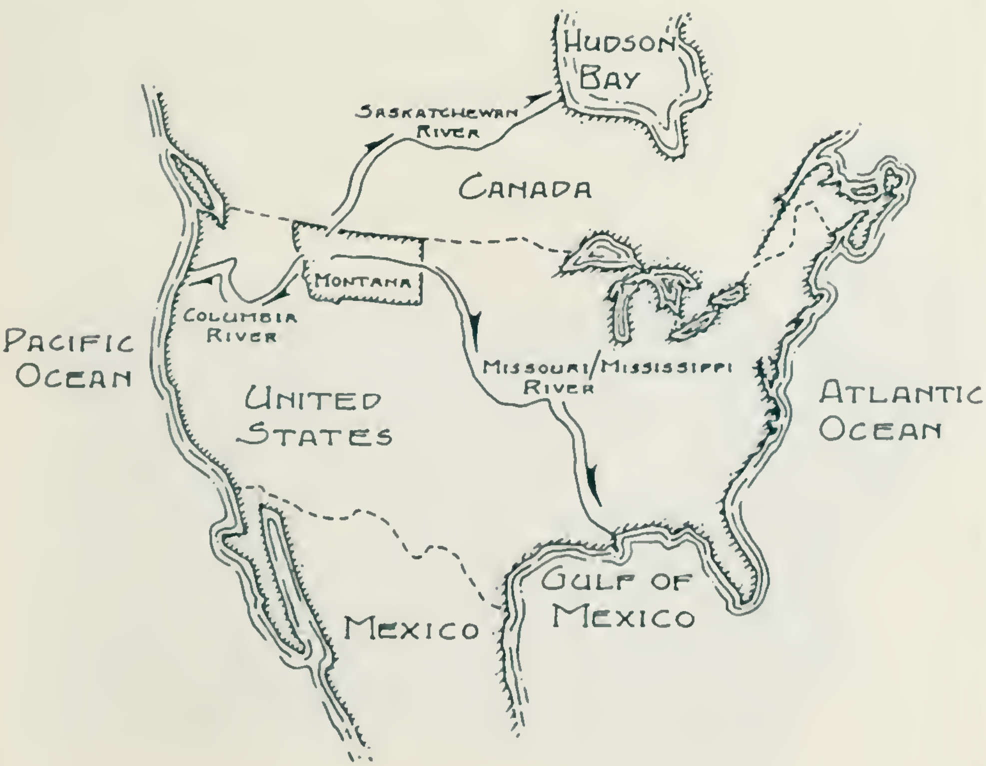
Photo courtesy Susan Higgins

Montana—Headwaters to a Continent

As the title of this publication and chapter suggests, Montana's water is important not only in Montana, but to much of the North American continent. High in Glacier National Park, water falling on Triple Divide Peak flows into three continental *river basins*, or *watersheds:*

- The **Clark Fork of the Columbia River and the Kootenai River** and their tributaries feed the Columbia River system, which empties into the Pacific Ocean.
- The **Missouri River** and tributaries (including the Yellowstone and Little Missouri) join the Mississippi, which drains into the Gulf of Mexico.
- The **St. Mary's River** feeds the north-flowing Saskatchewan River, which empties into Hudson Bay.

These three continental watersheds collect water from Montana's 93 million acres and send it into the four bordering states—Idaho, Wyoming, South Dakota, and North Dakota. Waters also cross into and originate from Canada along Montana's 550-mile northern border, which spans all of Alberta and part of British Columbia and Saskatchewan.



Montana, the fourth largest state, is populated by fewer than one million people (1993 figures estimated a population of 839,000), and water is crucial to everyone's daily lives. Rural communities, where almost half of all Montanans live, depend on water for personal needs, agriculture, recreation, tourism, and other uses. Urban communities, most of which are located along rivers, have depended heavily on water resources throughout their development. (See Map A in the center section; it shows population density, major towns, and watercourses.)

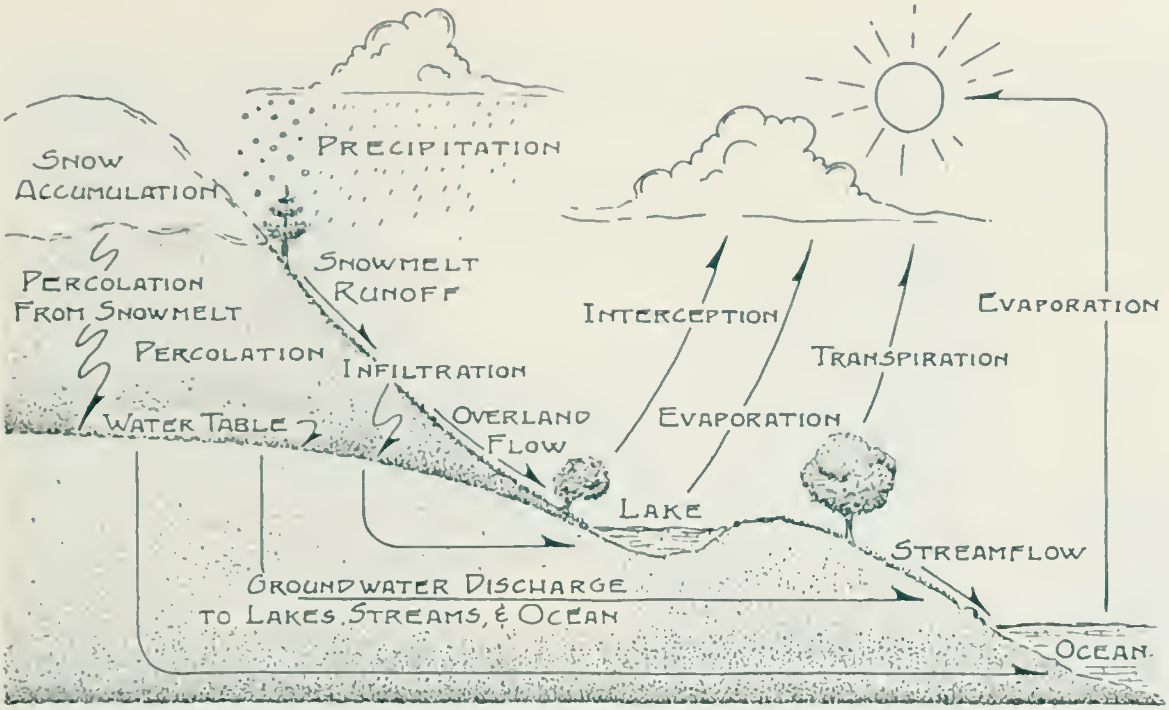
Geographers divide Montana into two major *physiographic* regions: the Northern Rocky Mountains and the Great Plains. Each has a unique topography, geology, and climate (see map below.)

The Northern Rocky Mountain region of western Montana includes the Continental Divide and ranges of the Rocky Mountain Cordillera, and is the source for much of the state *headwaters*. Montana's highest and lowest elevations occur in this region: Granite Peak in the Beartooth Mountains, at 12,799 feet above sea level; and the Kootenai River valley near Troy, Montana, at about 1,800 feet above sea level. Climate varies as much as the elevations: some areas east of the Continental Divide receive as little as ten inches of precipitation; areas west of the Continental Divide, where air masses meet the Rocky Mountains, may receive up to 100 inches of rain. (See Map B, Precipitation, in the center section.)

Montana's Great Plains roll across more than half the state. Several island mountain ranges thrust above the plains, but the region is primarily a broad, sloping plain carved by many river valleys and deeply cut by the Missouri and Yellowstone rivers. Much less precipitation falls here than in the Northern Rocky Mountain region—as little as six inches of rain in some areas. Reflecting this arid climate, the larger rivers flow year-round but many smaller waterways dry up during the summer. Water is commonly stored in *bedrock* and *alluvial* deposits.

Land-use patterns in Montana vary with the landscape. Even though rain is sparse in many areas, farming and ranching occur on about two-thirds (66 percent) of Montana's land. Irrigation makes much of this farming possible. Forests and woodlands occupy 23 percent of Montana's land, and provide timber and recreation. *Surface water*—lakes, rivers, reservoirs, *wetlands*—cover about one percent of the land, totaling more than 1,600 square miles. Urban areas occupy another one percent of the land. (See Map C, Land Use, in the center section.)

A physiographic map of Montana. Courtesy Natural Resource Information System, State Library. Based on U.S. Geological Survey data



The water cycle

A Place in the Hydrologic Cycle

Globally, the hydrologic cycle is the circulation of water from the oceans to the atmosphere, to the earth's surface and beneath, and back to the oceans. Locally, the hydrologic cycle begins with precipitation in the form of rain and snow. Rain evaporates into the atmosphere, runs off across the land to surface water bodies (wetlands, lakes, rivers), or seeps into the ground to be stored as *ground water*. Much of Montana's snow accumulates during the fall and winter in the mountains as snowpack and then melts in the spring, seeping into ground water, collecting in wetlands, or flowing into streams and rivers.

Ground water lies in *aquifers*, porous materials beneath the ground surface. Water supplies vary according to the porosity (the percentage of soil/rock volume occupied by air spaces) and permeability (the capacity of aquifers to transmit water). Ground water is pumped from the ground for many uses. It is a critical part of the hydrologic cycle because it *discharges* on Earth's surface and *recharges* aquifers, rivers, and lakes.

The Historical Significance of Water in Montana

Water has shaped the state's landscape, guided patterns of settlement, and influenced personal dreams and ambitions throughout Montana's history. Montana's indigenous people migrated to this region either in flight from other groups or in search of buffalo hunting grounds. Many of them traveled by water and fished or hunted for animals that lived near water. Both in the past and today, water figures prominently in the cultural and religious beliefs of Montana's Indians, who also possess legal rights to water resources in the state.

Montana rivers provided important lifelines to European Americans exploring and settling the West during the 1800s. This period began when President Thomas Jefferson ordered Meriwether Lewis and William Clark to explore the uncharted Louisiana Purchase. Their expedition, which spanned 1804 to 1806, traveled up the Missouri River through the heart of this new part of the United States. In 1805, they passed the confluence of the Yellowstone River. They continued traveling more than 1,000 miles

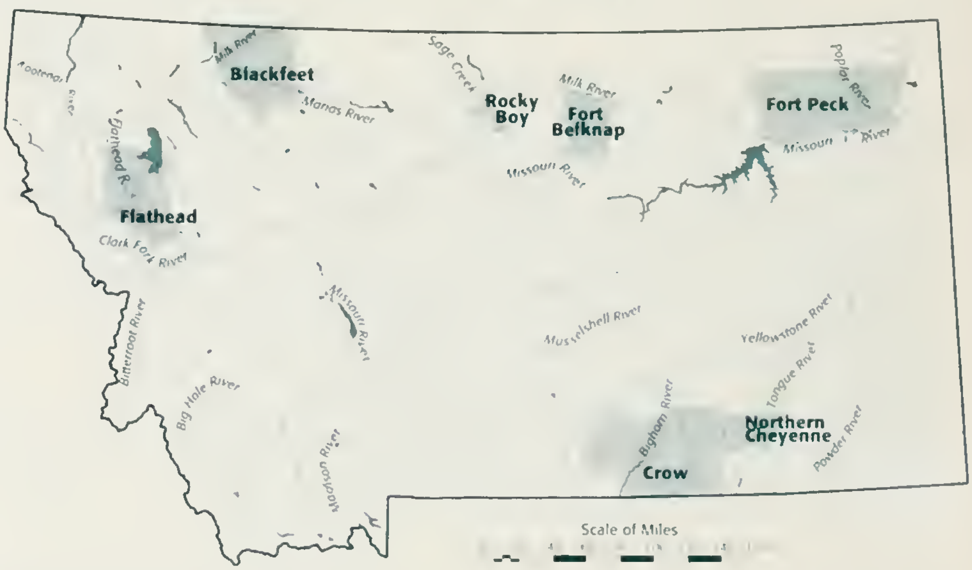
Where in the World is Water?

- Most—97.21 percent—of the world's water is salty water in the oceans and seas. A tiny amount of this water is treated to remove the salt and provide drinking water for some people.
- Another 2.15 percent of the world's water is fresh water, but most of that is unavailable to humans because it is frozen in ice caps and glaciers.
- Less than one percent—0.67 —of the world's water provides the freshwater needs of humans, many other animals, and most plants. This precious fresh water is found in lakes and rivers, but occurs mostly as ground water.

Reprint of John Mix Stanley's "Crossing the Milk River" Courtesy Gene Autry Western Heritage Museum, Los Angeles, CA

on Montana's rivers, naming many of the waterways en route: the Milk, Marias, Musselshell, Madison, Gallatin, Jefferson, Yellowstone, and the Bitterroot. The expedition observed large numbers of bison, elk, big horn sheep, and grizzly bears along river corridors and an abundance of native fish species like the cutthroat trout, bull trout, and arctic grayling.

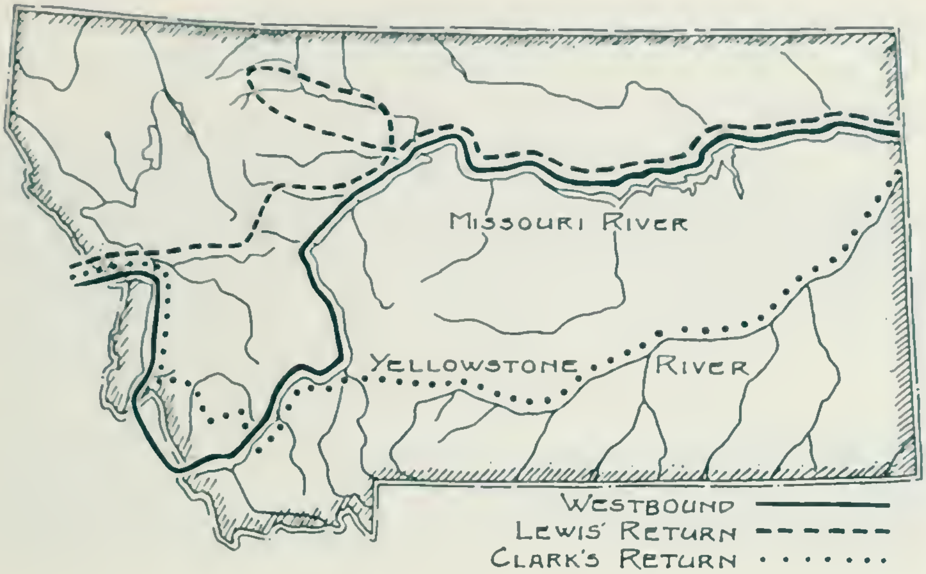
An era of fur trapping and trading followed close on the heels of Lewis and Clark. In 1807, Manuel Lisa's Missouri Fur Company established a fort in Montana at the mouth of the Bighorn River. His was the first American company to do so. Traders brought in supplies on flat-bottomed keelboats and carried out furs and hides of mink, beaver, otter, elk, deer and bison. The fur and hide trade continued into the 1850s, using more efficient steamboats to transport furs to St. Louis, the center of America's fur trade.



Montana's seven Indian reservations established between 1850-1916. Map courtesy Natural Resource Information System, State Library

Indians in Montana

Today, Montana is the home of 40,000 indigenous people, most of whom live on one of seven reservations, or in the state's major cities. Indian reservations each operate as sovereign governments, using a Tribal Council for decision making.



Historian H.M. Chittenden described the arrival of the first paddlewheel steamboats at Ft. Benton as a "celebrated feat of steamboat navigation . . . reach(ing) a point farther from the sea by a continuous water course than any other boat had ever done."

Native American [illegible] Helena. Photo courtesy Montana Historical Society, Helena, Montana.

Steamboat travel up the Missouri began in 1832 when the Yellowstone docked at the Fort Union trading post near the confluence with the Yellowstone River. During the great gold rush in the 1860s, Fort Benton—upstream of Fort Union—became the steamboat capital of Montana.

Montana's gold rush started when miners struck gold at Grasshopper Creek at Bannack, in 1862. Towns sprang up overnight to support prospectors surging into the gold country of central and southwestern Montana. From 1862 to 1876, miners in more than 500 camps worked *placer gold* deposits. Placer mining requires dredging streams and pouring the rocks down a sluice. Miners needed a great deal of water and they obtained it by damming and diverting many streams. By 1870, ditches and canals for mining and irrigation totaled 1,200 miles. You can see the heaps of washed stream gravels and cobbles that remain from this type of mining as you drive along State Route 287 on either side of Virginia City, and in other parts of the gold-rush region.

This intensive use of water prompted development of a system of claims for water, better known as *water rights*. Miners from the gold fields of California brought with them the *Prior Appropriation Doctrine* for regulating water use. It holds that the first person to divert and use the water has the best right to use the water—"First in time, first in right." This system was adopted in Montana. It provided a means to allocate water in times of drought, when competition for water increased. It also helped to protect landowners' costly investments of time, labor, and dollars that they made to

Montana Tribes and Reservation Headquarters

Reservation	*Headquarters*	*Date Established*	*Tribe*
Blackfeet	Browning	1851	Blackfeet
Crow	Crow Agency	1851	Crow
Flathead	Pablo	1856	Confederated Salish and Kootenai
Fort Belknap	Fort Belknap Agency Harlem	1888	Assiniboine and Gros Ventre
Fort Peck	Poplar	1888	Assiniboine and Sioux
Northern Cheyenne	Lame Deer	1884	Northern Cheyenne
Rocky Boy	Box Elder	1916	Chippewa/Cree

The Little Shell Band of Chippewa-Cree is presently seeking federal recognition. The tribe is headquartered in Montana, but does not have a land reservation.

Hydropower

Water power was first developed at Black Eagle Falls in 1890 for the copper smelter at Great Falls. Soon after many small hydropower facilities were built to produce cheap electricity for processing ore in Butte and Anaconda.

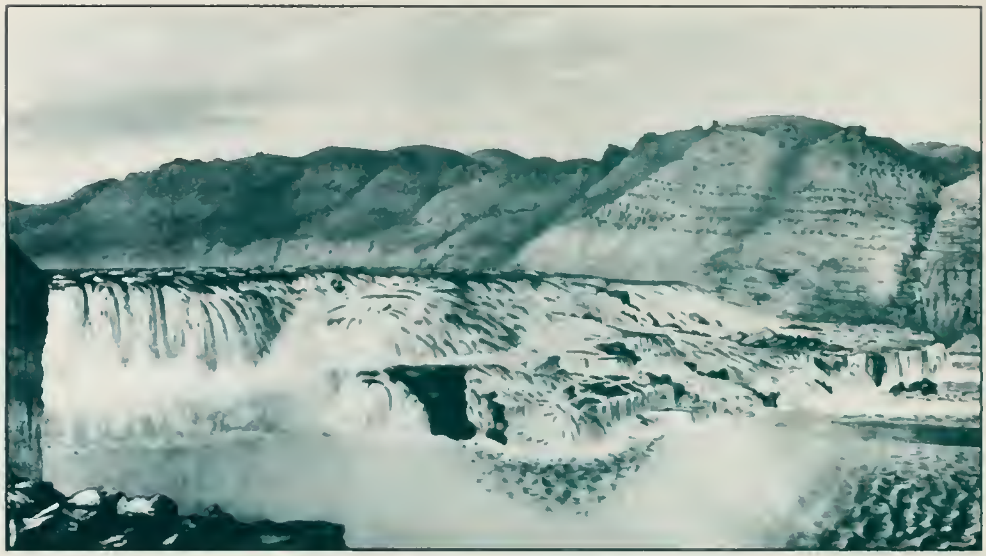
Hauling Water to the Homestead

Paul DeVore recalls his father's water excursions on their Wibaux area farm:

"It was two miles from our new Montana home to the nearest source of (good) water. A partially dug-out, board-walled spring on a section of railroad land had, for many years, been the only supply of water for a number of families in the community. Four 50-gallon wooden barrels were needed to haul and store the water. Two or three times weekly Dad drove to the spring with two empty barrels, dipped the water from the spring with a rope and pail and upon arriving home emptied the water, pailful by pailful, into two other barrels kept in the kitchen or adjoining coalshed. A frog, snake or occasional mouse had to be baled out of the spring before filling the barrels, but that was better than drinking the slippery alkali water from a nearby well or from Cottonwood Creek which ran through the south end of their place."

Not in Precious Metals Alone—A Manuscript History of Montana. 1976. Montana Historical Society.

Emigration Commissioner F.M. Thompson wrote in 1865: " after crossing the Dearborn River, ninety miles from Fort Benton, upon the head-waters of nearly every stream running from the mountains, mining operations are going on."



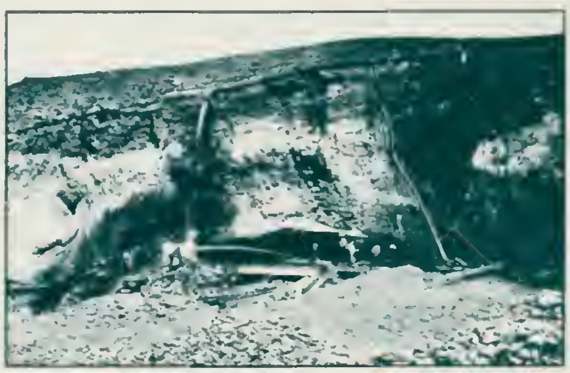
Lewis described the Great Falls of the Missouri as a "sublimely grand spectacle" even though it greatly delayed their travels. They needed an entire month to portage the falls. A. E. Matthews etching of the Great Falls, circa 1867. Photo courtesy Montana Historical Society, Helena, Montana.

bring water to needed locations. Among the first water rights recorded in local court houses are those of placer gold miners in 1863 on Alder Creek near Virginia City.

The same year as the Bannack gold strike—1862—Congress passed the Homestead Act. This act provided free 160-acre farms to all American citizens whose settlement efforts endured a five-year trial period. The first homestead application for land in Montana was filed in 1868. By 1870, 851 farms existed in Montana. This number grew to 13,097 farms in 1900. Much of this agricultural expansion occurred in periods of high rainfall. Still, only those settlers lucky enough to homestead land near a stream could obtain water easily. Most settlers endured the backbreaking labor of hauling water—sometimes from sources that were miles away from their farms.

In the 1880s, after the gold rush had slowed and homesteaders were well on their way to settling Montana, the livestock industry took off. In just a few years, the ranges were overstocked with cattle herded from Texas, Oregon, and Washington. A record harsh winter in 1886 killed 60 percent of the livestock in the Montana Territory. As a result, ranchers began to irrigate more river-bottom lands to produce feed for carrying herds through the long winters.

To aid in these irrigation and mining efforts, the United States government began building several hydropower dams and irrigation projects in the 1890s. The Huntley Irrigation Project was completed near Billings in 1902. Dams were completed on the Milk and Sun rivers in 1906. In 1905, the Bureau of Reclamation began construction of



Early Mining. Photo courtesy Montana Historical Society, Helena, Montana

the Lower Yellowstone Irrigation Project near Sidney, helping to transform the Montana frontier into a prosperous agricultural region.

These irrigation projects of the early 1900s succeeded in helping ranchers grow more feed, but they didn't protect homesteaders from a drought that lasted from 1929 to 1942. This prolonged dry period forced many homesteaders off their land; those who stayed knew that they could not depend on rain. The U.S. Congress and the Montana legislature responded by funding construction of large multipurpose storage reservoirs that would provide water during future droughts. Beginning in 1933, the federal government built six projects in Montana, including the Fort Peck Dam on the Missouri River, the Yellowtail Dam on the Bighorn River, and the Hungry Horse Dam on the South Fork of the Flathead River.

Irrigation of more and more land increased the chances for soil erosion problems. To deal with them, soil conservation districts were established in each county, and were governed by a local board of farmers and ranchers.

Montana's recreation and tourism industries have also depended on water for decades. In the late 1890s and early 1900s, entrepreneurs built beautiful hotels to capitalize on hot springs. These drew visitors from around the country. Today, millions of people—both residents and visitors from out of state—fish, boat, and swim in Montana's pristine lakes, wild rivers, and trout streams.

In Montana, many laws protect our valued water. These protections are developed when issues arise which require publicly-defined solutions. For example, during the national energy shortages of the early 1970s, many proposals arose to develop Montana's vast underground coal reserves. Some of these plans, such as sending coal slurry through pipelines to other states, would have involved massive amounts of water. Other coal-development plans threatened water quality. As a consequence of the public debate that ensued, Montana adopted *water reservation* legislation in 1973 that established a program allowing public organizations to seek water rights to protect water levels and provide for future uses. This and other federal and state water laws are described in Chapter 6.

Roosevelt at Fort Peck. Photo Courtesy Montana Historical Society, Helena, Montana

Ice Harvesting. Photo courtesy Montana Historical Society, Helena, Montana

Ice Harvesting

During the winter, some ranchers harvested huge blocks of ice to provide a year's water supply for drinking and cooking. In 1901, Luke Sweetman's Lakeside Ranch, which had no well or spring, harvested 36-inch thick blocks of ice from the Missouri River. They cut the ice with axes, crowbars, and saws, then roped and hauled it by horse-drawn bobsleds back to the ranch where they stored the ice underground. In later years, they stored ice in an above-ground, insulated ice house. They insulated the ice blocks with layers of sawdust or straw, which also allowed them to easily separate the ice blocks. When they needed ice for drinking, cooking, or washing, they hauled the blocks to an ice box or large drum in the kitchen.

Construction of Fort Peck.

Construction began in 1933 on Fort Peck Dam, Montana's largest human made structure. At one point, this Public Works Administration project provided jobs for 10,000 workers. The reservoir was completed in 1940 and now stores water for flood control, irrigation, navigation, and recreation. The dam also generates hydropower, providing electricity for farms and ranches. Fort Peck is the fifth largest dam in the United States. Its reservoir has a maximum capacity of 19 million acre feet and a length of 134 miles.

Hot Spring Resorts

Touting a combination of medicinal benefits, lavish lodging, and recreation, resorts of elegant architecture were constructed at Hunter's, Chico, Broadwater Hot Springs, and Boulder Hot Springs, to name a few, in the late 1800s. Broadwater Natatorium and Hotel near Helena boasted a bathing plunge larger than a football field, 100 steam-heated dressing rooms, and ten-course meals. This era of hot spring grandeur declined by the 1940s, although many resorts operate today on a more modest scale.

Historical photo of hot springs resort. Photo courtesy Montana Historical Society, Helena, Montana

Today, concerns about water availability, water level, aquatic habitat, and consumption of water continue to inspire debate. Around the state, people discuss questions such as:

- To what extent should *instream flows* be protected?
- To what extent should important water use industries (like agriculture, water recreation) be sustained?
- Can both instream flows and *offstream uses* co-exist?

The search for solutions that allow continued use and protection of our water has made one fact clear:

All Montanans play a role in determining Montana's water future.

For More Information

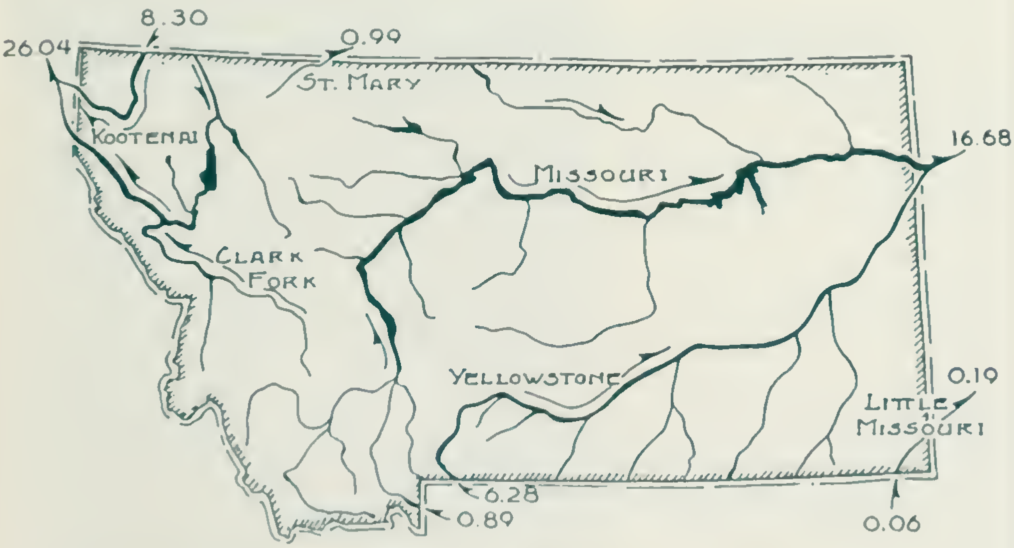
- *Natural Resources in Montana's History.* 1987. Montana Department of Natural Resources and Conservation.
- Montana Historical Society in Helena
- Your local historical museum
- The Liquid Treasure Water History Trunk and companion publication *Learning from the Past.* The Montana Watercourse, Montana State University—Bozeman.

2 Water Availability in a Nutshell

Climate dramatically influences Montana's water supply. Most of eastern Montana receives little precipitation and is classified as semi-arid. Western Montana receives much more rain. Areas within each region, though, experience extremes that make Montana both water-rich and water-poor, with localized floods and droughts. Because of its influence, weather is monitored closely by water managers who need to know the current conditions of the snowpack, streamflow, and reservoir levels in order to provide for Montana's water needs.

Surface Water

In an average year, about 44 million acre-feet of water flow out of Montana and 65 percent of this amount originates within state borders. Most of the remainder flows into Montana from Wyoming and Canada.



Montana's Water Budget. Water flowing into and out of the state in million acre-feet (maf)

Rivers

More than 170,000 miles of streams and rivers meander through Montana—53,000 miles are *perennial streams* that flow all year round, 117,000 miles are *intermittent*. (Of the 48 lower states, Montana ranks third in total stream miles.) Streamflows vary seasonally. The highest occur during April, May, and June as snow melts and spring rains fall. Much of this water is stored in reservoirs for use later in the year.

Water Equivalents

1 cubic foot
- = 7.48 gallons
- = 62.4 pounds of water

1 acre-foot
- = 43,560 cubic feet
- = 325,851 gallons

One acre-foot is the amount of water that covers one acre to a depth of one foot.

1 cubic foot per second (cfs)
- = 448.8 gallons per minute

1 cfs
- = 40 Montana statutory miner's inches

1 cfs
- = 646,272 gallons per day

For 24 hours = 1.983 acre-feet
For 30 days = 59.5 acre-feet
For one year = 724 acre-feet

1 million gallons
- = 3.07 acre-feet

1 million gallons per day (mgd)
- = 1,122 acre-feet per year

1,000 gallons per minute (gpm)
- = 2.23 cfs

1,000 gpm
- = 4.42 acre-feet per day

An acre-foot supplies a family of 5 for 1 year

44 million acre-feet flow out of Montana in an average year

River Stories

The Yellowstone River, called "Elk River" by Native Americans, is the longest free-flowing river in the lower 48 states. The Milk River, named for its milky color, originates in Montana, enters Alberta, Canada, then turns southeast for a return to Montana. The Big Hole River is home to the last stream-dwelling arctic grayling, a rare fish species in the continental United States. Reaches of four rivers—the North Fork, South Fork, and Middle Fork of the Flathead River and the Missouri River downstream of Fort Benton—have been designated "Wild and Scenic" by the U.S. Congress to protect their natural beauty.

Reservoir Facts

Fort Peck Reservoir is Montana's largest, located on the Missouri River near Glasgow. Its shoreline is longer than the coastline of California.

Behind Yellowtail Dam on the Bighorn River, lies Bighorn Lake, which is the largest reservoir in the Yellowstone River basin and backs water into Wyoming. Hungry Horse Reservoir and Lake Koocanusa are large storage projects in the Columbia River headwaters. Lake Koocanusa, formed behind the 400-foot-high Libby Dam, gets its name from the first three letters in the name of the river, Kootenai; the first three letters of the word Canada, since it backs water into British Columbia, and the three-letter abbreviation for the United States of America, USA. The dam impounds 48 miles of the Kootenai River within Montana and extends another 43 miles into Canada.

Flathead Lake, although a natural lake, may be considered a reservoir, too, because its water level and storage is controlled by Kerr Dam.

Montana's many miles of streams supply three major river basins:

- The Columbia River basin, which has two major tributaries in Montana: The Clark Fork of the Columbia and the Kootenai River. Together, they drain about 25,152 square miles, annually releasing about 26 million acre-feet. These two mountainous river basins cover only about 17 percent of the state but generate almost 60 percent of the water.
- The Missouri River basin, the largest river basin in Montana, drains more than 82,000 square miles, or 56 percent of Montana's land base, but discharges only about 17 percent (8 million acre feet) of the state's average annual discharge.
- The Yellowstone River basin drains almost 36,000 square miles and sends roughly 9.5 million acre-feet into the Missouri, 21 percent of state's water.

Major River Basins of Montana

River Basin	*Area (sq. mi.)*	*Percentage of Montana's Area*	*Percentage of Montana's Water*
Columbia	25,152	17	59
Missouri	82,352	56	17
Yellowstone	35,890	24	21
Little Missouri	3,428	2	1
St. Mary's	648	1	2
Totals	***147,470***	***100***	***100***

Lakes and Reservoirs

Montana's landscape is dotted with more than 10,000 lakes and reservoirs, and thousands of smaller wetlands, stock ponds, and other water bodies. Glaciers created many of these features, such as Eastern Montana's prairie potholes. These seasonal wetlands are actually small depressions scoured in the plains by glacial action. Most of Montana's natural lakes occupy larger depressions carved by glaciers in the mountains of the western part of the state.

Canoeing on Swiftcurrent Lake. Photo courtesy Travel Montana

Flathead Lake is the largest freshwater lake in the United States west of the Great Lakes. Other large natural lakes include Whitefish, Swan, Seeley and Thompson lakes, all located in western Montana. Another large lake, Earthquake Lake, was formed not by glaciers but by a catastrophic earthquake landslide that dammed the Madison River in 1959.

Much of Montana's surface water is stored in reservoirs—artificial water bodies whose levels are controlled by dams. Larger "multipurpose" reservoirs were constructed by the federal government for hydroelectric power generation, flood control, storage for irrigation, and recreation. Sixty-seven reservoirs each have a capacity of 5,000 acre-feet or more. These are owned and managed today by the federal government, the State of Montana or private utilities.

Wetland photo courtesy Susan H[illegible]

Wetlands and Riparian Areas

Wetlands are areas defined by a high water table, wet soils, and water-loving vegetation. They include *riparian* areas bordering streams, seasonal prairie potholes on the plains of eastern Montana, and isolated cattail-filled marshes.

Wetlands fulfill a number of roles. As pollution modifiers, they filter out pollutants from runoff, thereby reducing contamination of rivers and streams. Wetland plants absorb phosphates and nitrogen, two nutrients that accrue from land-use practices. They can act like sponges, storing excess precipitation to reduce flooding and recharge ground water. Wetlands also support ecological diversity. They provide important habitat for birds of all kinds—waterfowl, shorebirds, songbirds, raptors—and for insects, amphibians, and mammals such as white-tailed deer. They also provide people with places to relax, watch wildlife, and take photographs.

Until recently, though, most people did not appreciate the value of wetlands. By some estimates, wetlands have declined by about 27 percent in Montana over the last two centuries.

Ground Water

Water that seeps or percolates through soil and is stored below ground is called ground water. An aquifer is a sub-surface storage area for ground water from which water can be pumped. Aquifers usually are saturated zones of sand, gravel, fractured bedrock, or other material that have space between particles to hold water. They are recharged by precipitation and streamflow. In turn, they recharge streams during the summer and other periods of low streamflow. The map on the following page shows some of the near-surface aquifers commonly tapped in Montana.

Aquifer distribution and ground-water availability vary across the state's two distinct hydrogeologic regions: the Great Plains Province (eastern and north-central Montana), and the Northern and Middle Rocky Mountains Province (western and

Major Reservoirs in Montana

Reservoir	River	Capacity(acre-feet)	Owned by	Uses*
Canyon Ferry	Missouri	2,051,000	U.S.D.I. Bureau of Reclamation (BuRec)	FC, I, FW, P
Clark Canyon	Beaverhead	328,900	BuRec	FC, I, FW
Fort Peck	Missouri	19,410,000	BuRec	M, FC, P, I, FW
Fresno	Milk	129,000	BuRec	FW, M, I, FC
Gibson	Sun	105,000	BuRec	I, FW
Hebgen Dam	Madison	273,000	Montana Power Company (MPC)	P
Holter	Missouri	245,000	MPC	P
Hungry Horse	S. Fork Flathead	3,468,000	BuRec	FC, P, FW
Kerr	Flathead	1,220,000	MPC	P
Koocanusa (Libby)	Kootenai	5,850,000	U. S. Army Corps of Engineers	FC, P, FW
Lake Francis	Dry Fork Marias	105,000	Pondera Canal andReservoir Co.	I
Noxon	Clark Fork	495,000	Washington Water and Power Company	P
Tiber	Marias	1,368,000	BuRec	FW, I, FC, M
Bighorn	Bighorn	1,375,000	BuRec	I, FC, P, FW

Uses FW–fish and wildlife, I–irrigation, P–power generation, FC–flood control, M–municipal

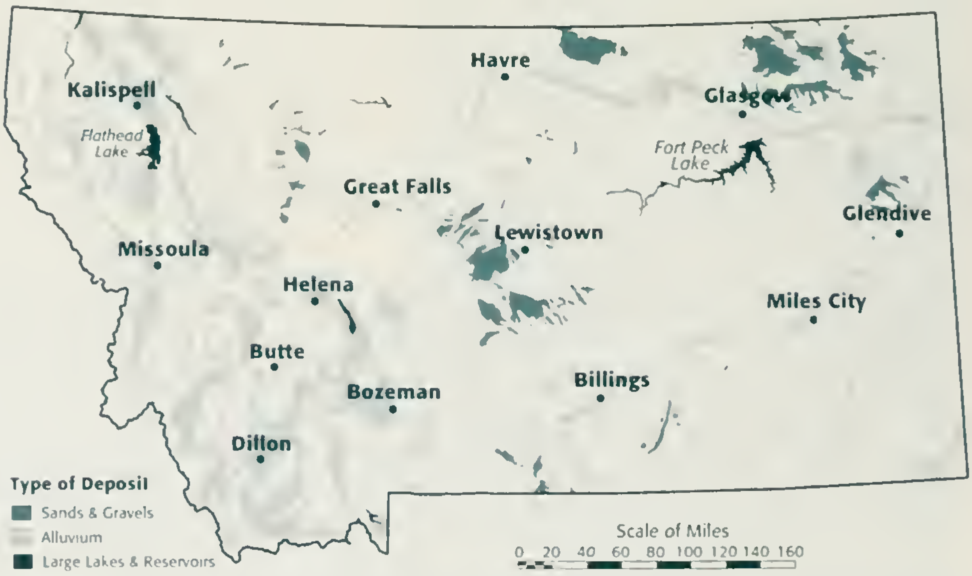
south-central Montana). Most ground water in Montana is obtained along major streams from aquifers composed of alluvial (stream-deposited) sediments of gravel, sand, silt, and clay. (See map below.)

In western Montana, these aquifers are located mostly in river valleys where ground water is plentiful and the quality is generally excellent; they are recharged by precipitation and streamflow. In eastern Montana, alluvial aquifers consist of fine-grained, consolidated sandstone and siltstone. In these aquifers, water movement is slower. This is due, in part, to lower amounts of precipitation. However, water moves faster in deeper aquifers made of cracked rock, gravel, or coal. Examples of these deep aquifers include the Fort Union Formation and the Eagle Sandstone coal-bearing aquifers.

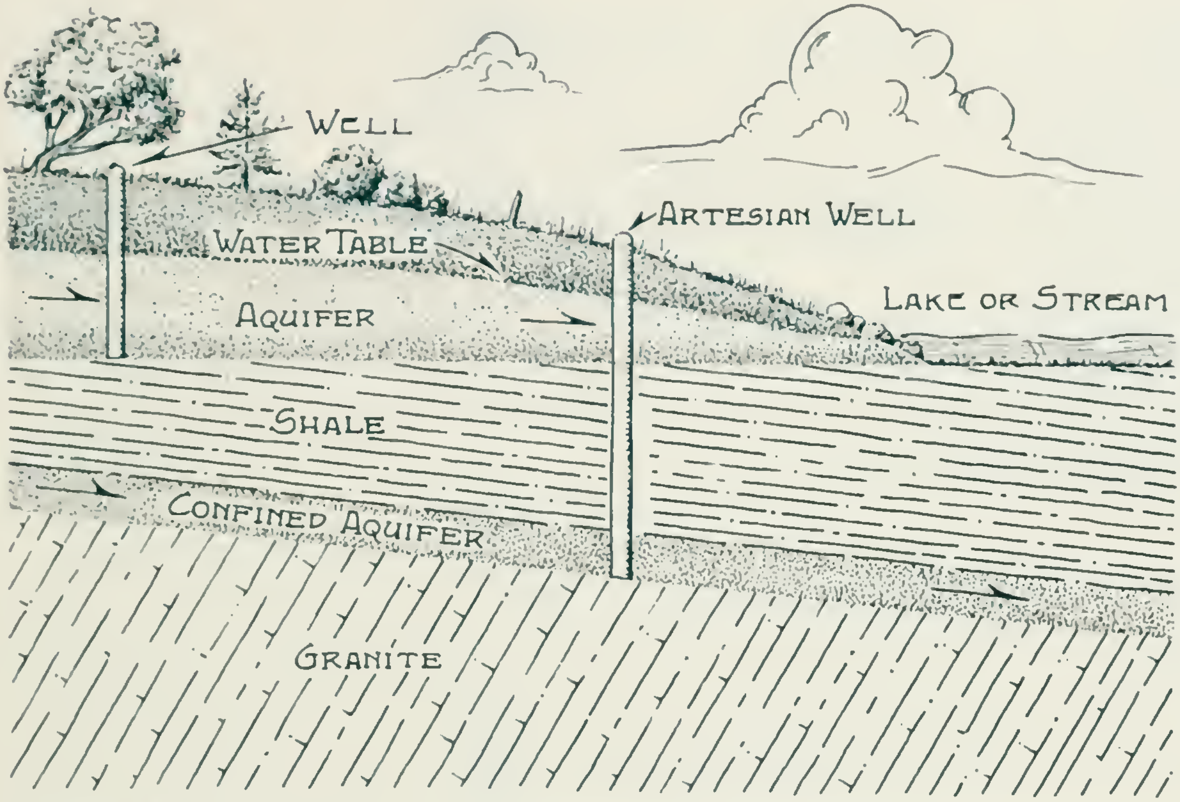
Geothermal Aquifer Resources

Montana's many geothermal features attest to the volcanic activity that shaped much of the landscape. Geothermal springs form when ground water is heated, either by hot rock, natural radioactive decay, or chemical reactions. Natural hot spring temperatures range from 50 to 190 degrees F. Oil well drillers have encountered geothermal water edging up to 240 degrees F! Although most abundant in Yellowstone National Park, hot springs are found throughout Montana. They are concentrated in the western part of the state, where approximately 60 of the state's 80 hot springs are located.

Using special piping, some people have developed geothermal resources for household and industrial heat and power. Potential commercial uses of geothermal energy include catfish farming and greenhouse heating. This use of Montana's hot water is restricted in the region bordering Yellowstone National Park because tapping the geothermal sources may alter the park's unique thermal features.



Montana's surficial aquifers. Composed largely of younger unconsolidated sediments deposited by streams, glaciers or glacial meltwater. These aquifers are the most accessible and of highest quality. Map courtesy Natural Resource Information System, State Library. Data from Montana Bureau of Mines and Geology.



Ground water profile

Principal Ground Water Sources in Montana[1]

Aquifer[2]	*Depth (ft)*	*Composition*	*Yield[3] (gal/min)*	*Dissolved[4] Solids (mg/L)*	*Quality*
Alluvial	0-200	loose sand, silt, clay	10-1,000	300-2,500	good-excellent
Commonly used in heavily populated areas, subject to contamination					
Fort Union	250-9,000	coal or sandstone	< 15	500-5,000	fair
Most commonly used aquifer in eastern Montana, although water from most wells drilled here exceed federal drinking water standards for total dissolved solids					
Fox Hills/Hell Creek	1,200-2,500	sandstone	20-50	100-4,000	excellent
Underlies Fort Union aquifer					
Judith River	100-1,200	coal seams, sandstone, shale	50-100	160-27,000	fair
Eagle/Virgelle	200-700	sandstone	50-500	800-1,500	good
Used often in central Montana, but depth and poor water quality limit use in eastern Montana					
Kootenai	500-1,000	sandstone	10-300	200-14,000	fair
Swift	3,000-5,000	sandstone, shale	50	500-4,000	fair
Mainly oil exploration holes used for stock water					
Madison	300-16,000	limestone	20-6,000	500-300,000	poor-excellent
Underlies entire Great Plains. Very high quality near Big Springs at Lewistown, low in northeast Montana where high yields can be used for industrial purposes					

1 Adapted from Montana Water Quality Guidebook 1993 Montana State University Extension Service, page 3

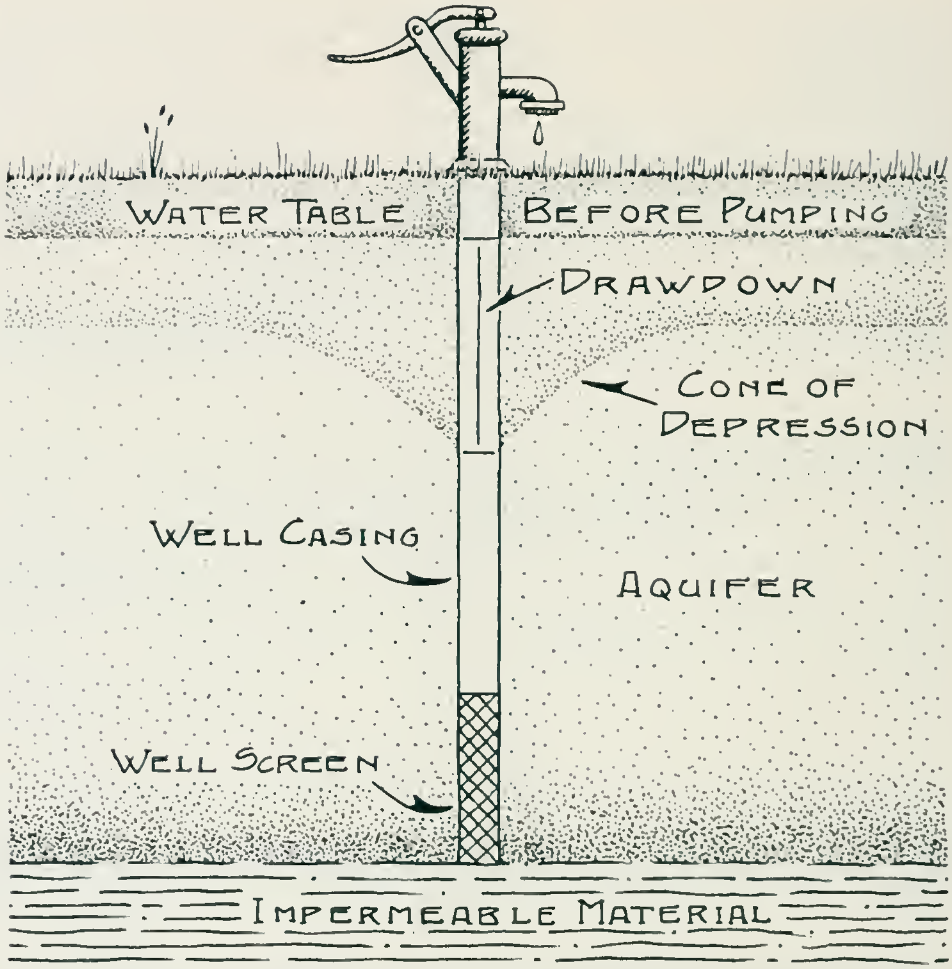
2 Alluvial aquifers are located throughout Montana, others in chart are deeper formations east of the Continental Divide

3 A water right permit is required for wells that produce more than 35 gallons per minute

4 Federal drinking water standards permit a maximum of 500 mg/L Total Dissolved Solids in public supplies

What Are Pump Tests? Why Are They Necessary?

To use ground water, a well must be drilled into an aquifer, and the water then pumped to the surface. Pump tests determine aquifer characteristics—water quality and quantity—or the performance characteristics of a well. At new homesites, the pump test helps determine the drawdown (the difference between the natural water table and the water level during pumping) in a well, and the effect of new withdrawals on existing wells. Knowing these factors helps calculate the *transmissivity* (the rate at which water is transmitted through an aquifer) and *well yield* (the volume of water discharged from a well in gallons per minute) of the aquifer. It also helps you know what type of pump to purchase in order to minimize power and maintenance costs. Proper well construction is critical for prevention of coliform bacteria contamination.



For More Information

- *Montana Water Supply and Moisture Condition Report,* Monthly. Department of Natural Resources and Conservation
- Contact:

  —Water Rights Bureau of the Department of Natural Resources and Conservation or one of its statewide field offices for water rights information

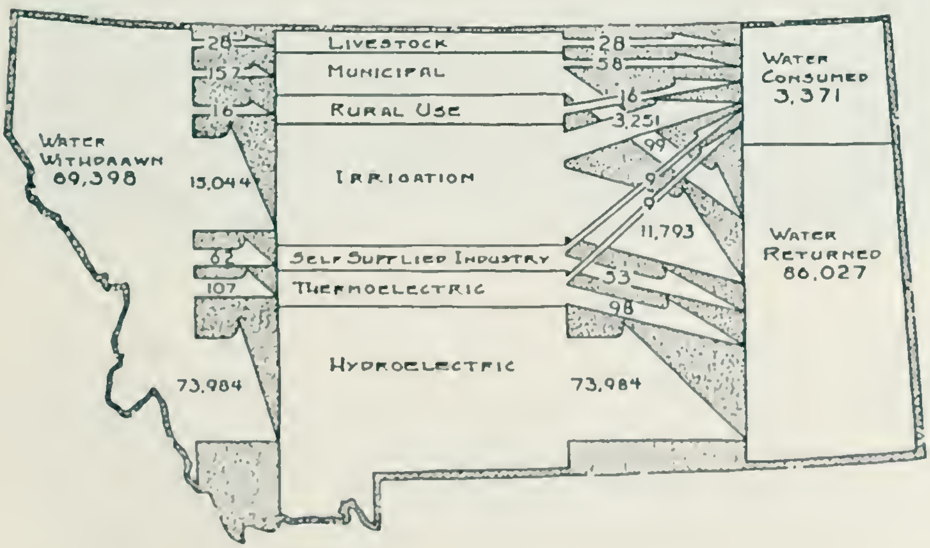
  —Montana Bureau of Mines and Geology's Ground Water Information Center for water-well logs and monitoring programs
- *Montana Water Supply and Use, Montana Ground Water,* and other publications. U.S. Geological Survey.
- *Montana Ground Water Atlas.* 1995. Montana Natural Resources Information System, Montana State Library.
- *Occurrence and Characteristics of Ground Water in Montana.* 1982. Montana Bureau of Mines and Geology. Publication #99.

3 Ways That We Use Water

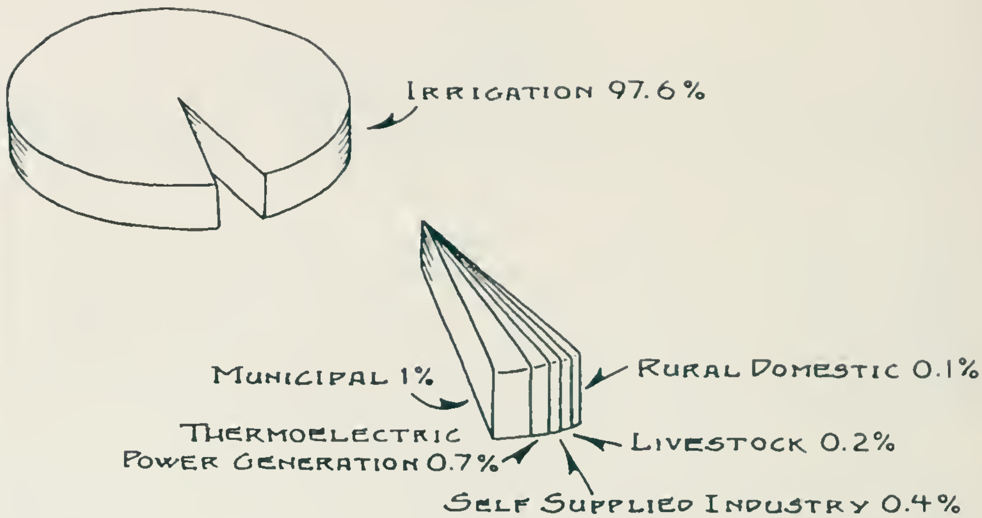
Montanans use water in homes, on land, and in industries. We also use the state's streams, rivers, and lakes for recreation. When we use water for such things as cooking, irrigation, or mineral extraction, we are using it offstream. When we use water for recreation or to produce hydroelectric power, we are using it instream.

Generally, when we use water offstream, we are removing water for activities that consume it (*consumptive uses*). Offstream uses include irrigation, drinking water and municipal needs, rural domestic uses, self-supplied industry, livestock, and thermal electric power generation. We obtain water supplies from ground water that is pumped to the surface or from surface water that is diverted from rivers and reservoirs. The water consumed may produce livestock, crops, or manufactured goods. Or it may transpire through plants or evaporate into the atmosphere. The portion that is not consumed returns to the watershed further downstream as *return flow*.

When we use water instream, on the other hand, we are engaging in *nonconsumptive* activities that maintain flows and levels within stream channels and lakes and reservoirs. Instream uses include hydroelectric generation, maintenance of natural water quality conditions, fishery and wildlife habitat, and recreation.



Correction, Page 15: Caption at page bottom should read "Annual water use in Montana in thousand acre-feet (taf)."



Each year, Montanans withdraw approximately 15,414,000 acre-feet of water. We actually consume less than one-fourth of that water and the rest returns to rivers and aquifers. This chart shows the percentages of water withdrawn for a range of uses.

Data from Water Use in Montana, 1980. 1986. Department of Natural Resources and Conservation. This figure does not include evaporation from reservoirs.

Where Our Water Comes From

Whether we use water instream or offstream, it has to come from somewhere!
This chart shows major offstream uses, expressed in millions of gallons per day (mgd).

Water Use	Ground Water (mgd)	Surface Water (mgd)
Irrigation	90	8,910
Public Supply	51	83
Rural Domestic	15	1
Self-Supplied Industry	30	27
Livestock	16	35
Fossil Fuel Power Use	0	33
Mining	15	4
Total	***218***	***9,100***

Adapted from chart in Montana General Agricultural Chemical Ground Water Management Plan using provisional USGS 1993 data.

Irrigation And Livestock

Irrigation use reflects the size and importance of agriculture, the state's largest industry. Water withdrawn for irrigation accounts for more than 97 percent of the total amount of water withdrawn in Montana each year. It is used to irrigate as many as 2.8 million acres of Montana's 18 million acres of croplands. Although only three percent of irrigation water comes from ground water, that small percentage actually amounts to almost half of all the ground water withdrawn each year for all uses in Montana. It's no surprise that Montana ranks seventh in the nation in the number of acres irrigated.

What crops benefit from all of this water? Alfalfa, which is used to feed livestock in the winter, is the main irrigated crop. Other important irrigated crops include wheat, hay, barley, oats, sugar beets, potatoes, corn, and cherries.

A number of factors—distance from a water source, slope of the field, soil drainage, crop requirements, wind action—determine the amount of water needed and type of irrigation system used. Flood and sprinkler systems are most commonly used in Montana, and each varies in efficiency. (See illustration, page 18.)

Water is also essential for raising livestock—cattle, sheep, hogs, chickens, and other animals. The animals actually drink less than one percent of the water consumed in Montana. Most of the water associated with the livestock industry goes to producing livestock feed.

Who Irrigates, and How?

Individual landowners along watercourses commonly divert water for farm and ranch use, although specific organizations manage and distribute water for the shared benefit of many. Irrigation districts manage most federal irrigation projects and supply water to irrigators within a specified region. Water Users Associations manage mostly state-owned irrigation projects. Local irrigators set up ditch or canal companies to maintain ditch systems that serve their collective lands. You can read more about these organizations in Chapter 7.

Photo courtesy [illegible]

Public and Rural Domestic Water Supply

Montanans draw their daily water from either public water-supply systems or rural domestic water supplies. Approximately 200,000 people use rural domestic water supplies at a rate of about 78 gallons per day for drinking, bathing, washing, cooking, and lawn watering. Rural domestic water supplies depend on ground water—98 percent of their water comes from this source.

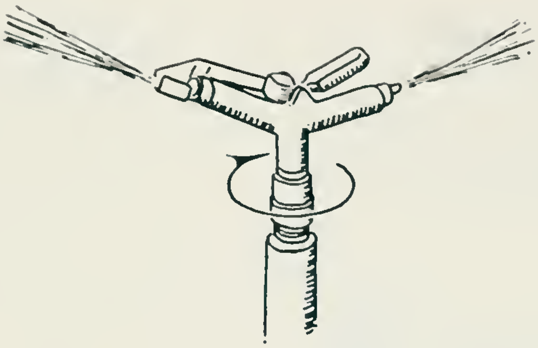
Three-fourths of Montanans (and many industries) obtain water from more than two thousand public water-supply systems. Most of these systems are small, serving less than 3,300 people. The few large systems, such as those in Billings and Great Falls, serve the majority of Montanans. Individuals served by public water supplies use around 140 gallons of water per day—an estimate that includes water for commercial and parkland uses.

Photo courtesy [illegible]

How Does Irrigation Work?

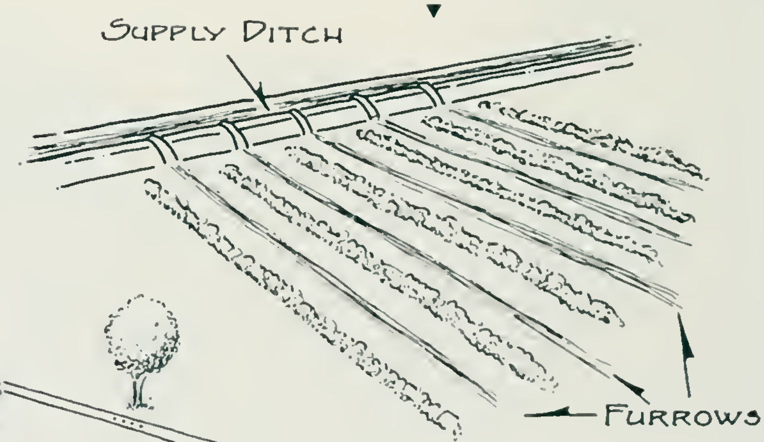
Sprinkler Systems

Using rotating sprinklers, spray nozzles, or perforated pipe, sprinkler systems spray water onto the land. They generally apply less water than the soil intake rate. Mainline and lateral pipes and sprinkler units, often in conjunction with pumps, transport water to crops either as multi-sprinkler (including center pivots), single-sprinkler (using a large, pressurized gun-type sprinkler), or boom sprinkler units. These systems can be moved by hand, tractor, or electrical units. While more water-efficient than flood irrigation, sprinkler systems require higher system head (pressure) and pumping costs. They can also change nearby ground water supplies, especially where flood irrigation had been recharging aquifers.



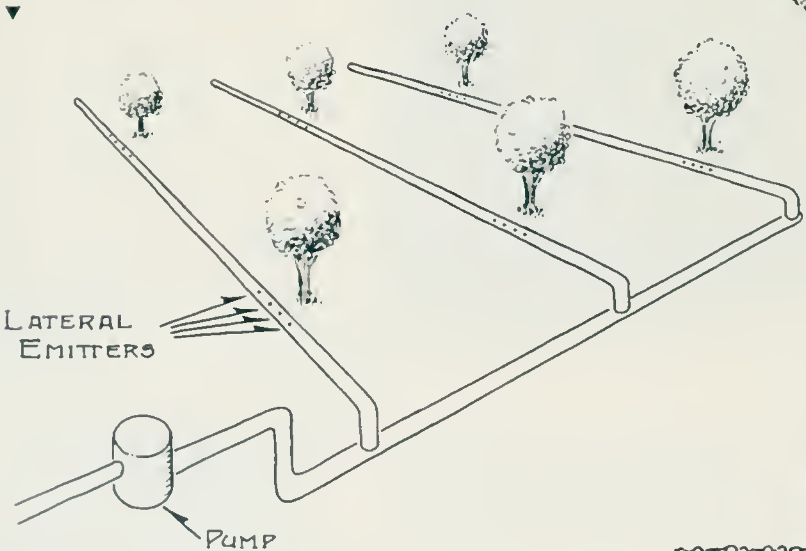
Surface or Flood Systems

Water is applied directly to the ground by flooding an entire field or guiding water down furrows. Typically, more water is applied than can be absorbed by the soil. These systems require a water supply, ditches, measuring devices, and turnouts for release of water onto the ground into furrows. The slope of the land and the rate of water intake by different soils affects the type of surface system used.



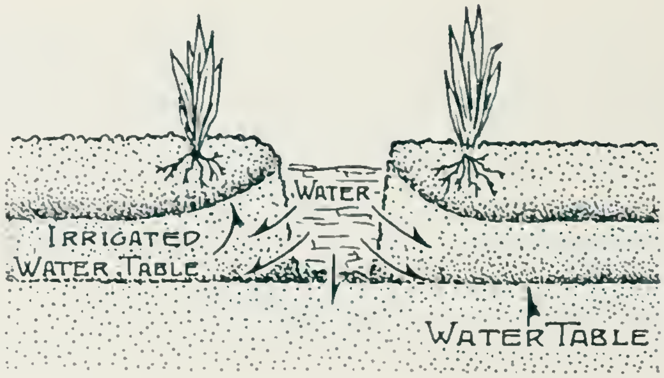
Drip/Trickle System

A pipe network slowly transports water directly onto or below the soil surface using emitters that continuously drip water. Drip systems use a pump, control head, main lines, laterals, and emitters.

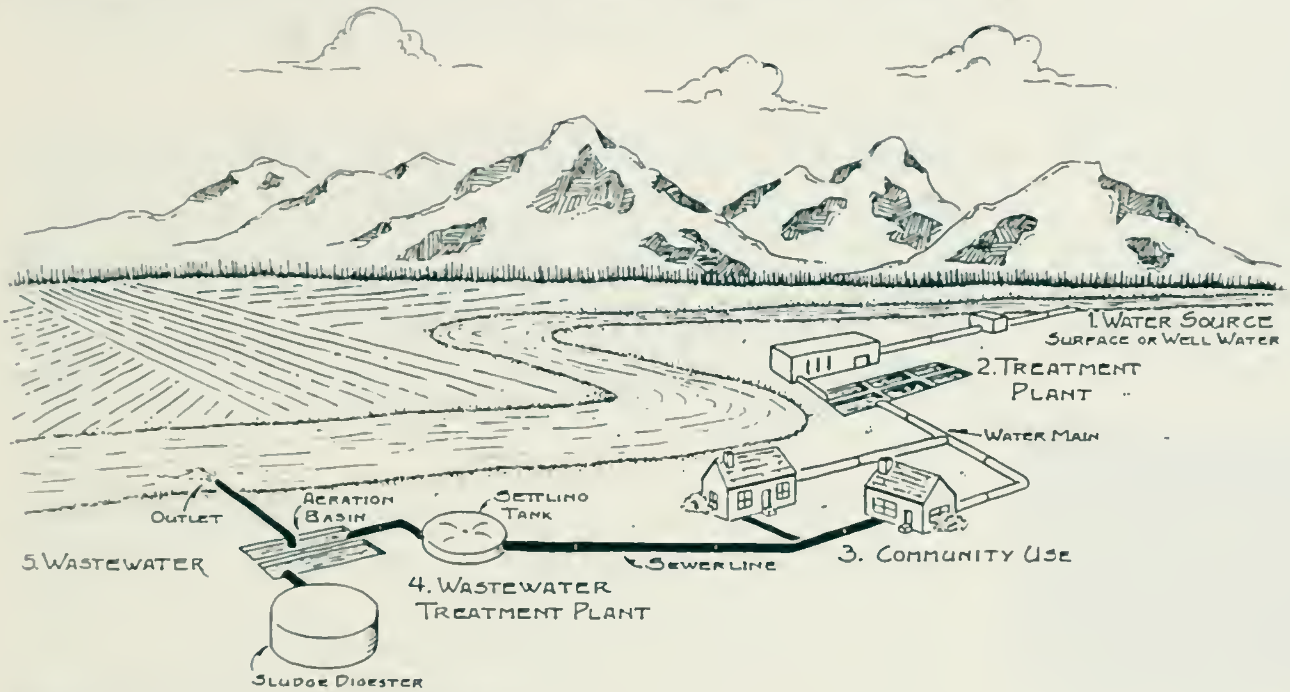


Below Surface Systems

Water is applied underground for migration to plant roots. This method is appropriate only for level lands with a high water table or an impervious layer below the root zone where the water table level can be sustained artificially.



Most public water supplies use some ground water, but it provides less than 40 percent of the total amount of water withdrawn for use by these utilities. Added all together, Montana's public water-supply systems use less than two percent of all water diverted. Although these uses are all considered consumptive, most of the water is returned to surface water or applied to the land after it has been used and treated.



A water supply system from river to faucet and back again

Non-Agricultural Industry

In Montana, some industries construct their own water delivery systems—they *self-supply* their water needs. These industries include petroleum refining, wood products manufacturing, sugar refining, and minerals mining industries. They use ground water and surface water about equally, and their total use of water equals less than one percent of all water diverted in Montana.

In western Montana, the wood products manufacturing industry withdraws the largest amount of water. In eastern Montana, petroleum and sugar-refining industries lead industrial consumers of water. Nationally, the trend for industrial water use is downward, primarily because water quality regulations for wastewater discharges have encouraged industries and governments to reuse and conserve more water.

Mining

More than 100 active mineral mines in Montana produce metals, industrial minerals, or fuels. Copper, gold, silver, and platinum are the most valuable metals extracted. Industrial minerals like talc, iron, limestone, and decorative stone are mined in various parts of the state. Oil and natural gas are pumped from underground. Coal is mined extensively in southeastern Montana, which contains more than one-fourth of the national coal reserves.

The amount of water needed for mining depends on the mining process employed. Placer mining uses water to separate valuable minerals from sand and gravel. A small placer mining operation might use 50 gallons per minute. Although this is considered a consumptive use, most of the water runs back into its source. Hard rock

A Look at Sugar Refining

Water keeps your sugar bowl full. Harvested sugar beets are washed with water. Then, in a resourceful recycling process, the solids settle out and the clear water is pumped back to wash more beets. The plot thickens—the wash water is actually a by-product of the cooling process that occurs when the sugar beets are processed. (The sugar beet is actually about 75 percent water.) When sugar from the beets goes into solution during heating, water is evaporated off and condensed with cool water. The water produced provides hundreds of gallons of water for many other process applications. Excess condensed water is treated in aerated ponds and released through a monitoring station. The only other water that is discharged and not reused is water that is used solely for equipment maintenance.

Words on Mining

Opencut mining
–Minerals are extracted from open pits such as a gravel pit.

Strip mining
–A coal mining process that "strips" the surface soil so that underground coal deposits can be extracted. Strip mining occurs south of Colstrip.

Placer mining
–Water separates valuable metals and non-metals from near-surface sand and gravel deposits. An example of placer mining is panning. Placer mining was prominent near Virginia City and other gold-rush areas.

Hard rock mining
–This type of mining often requires construction of underground shafts, or "room and pillar," from which ores are extracted. Hard rock mining can also occur in large open pits like the Golden Sunlight mine in Whitehall or the Berkeley Pit in Butte.

The Berkeley Pit. Photo courtesy Kevin Keenan

and open pit mine processing might use a heap leach method that extracts minerals, such as gold or copper, using a solution of water and cyanide or sulfuric acid. For example, the Continental Pit in Butte uses 15,000-18,000 gallons of water per minute (22-26 million gallons per day) to produce copper and molybdenum. Wastewater from such methods may be neutralized, reused, or recycled. Strip mining uses water primarily for controlling road dust, washing coal products, and maintaining equipment. Oil and gas exploration needs water for drilling fluids and equipment maintenance.

Wood Products

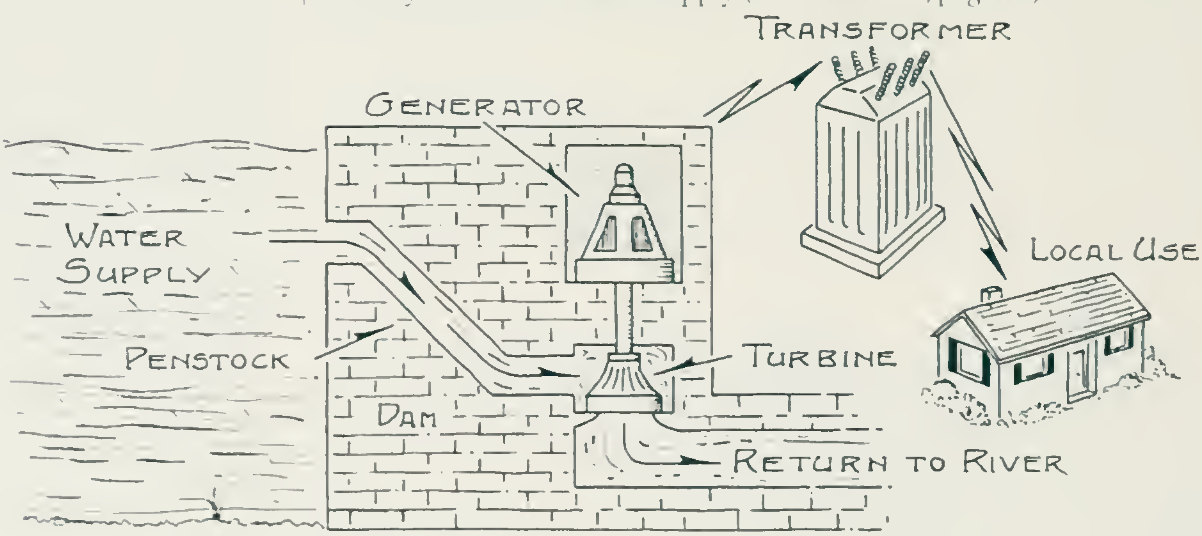
Montana's 200 forest products plants produce lumber, plywood, pulp and paper, particleboard, fiberboard, house logs, utility poles, posts, cedar products, and wood by-products. Pulp and paper mills consume the most water. To create pulp, water and chemicals are heated under pressure with wood chips. The resulting slurry is applied over large screens; the water drips out and the remaining fibers are steam-dried to become paper. The wastewater is treated before storage in large ponds for eventual discharge. For example, Stone Container pulp plant near Missoula withdraws ground water at a rate of 23 million gallons per day. Of this amount, 4 million gallons is returned to the Clark Fork River after cooling, 19 million gallons goes to storage ponds, and 1.9 million gallons evaporate.

Petroleum Refining

Oil refineries, which are located in Laurel, Billings, and Great Falls, process crude oil into gasoline and other petroleum products. They withdraw water to cool equipment and generate steam during the refining process.

Reservoir Storage and Hydroelectric Power Generation

Among their many uses, reservoirs in Montana store water for hydroelectric power generation. Evaporation from these reservoirs represents about one third of the total water consumed annually in the state. Even so, hydroelectric production is considered a nonconsumptive use because the process itself does not consume water—water released from one facility can be used again downstream. About 74 million acre-feet of water pass through Montana turbines every year, returning directly to the surface water supply. (See illustration, page 22.)



Hydroelectric Power Generation.

Thermal Electric Power Generation

Seven thermal electric power facilities operate in Montana: coal-fired plants in eastern Montana provide most of the thermal electric generating capacity; oil- or natural gas-fired units provide the remainder. Together, these plants use less than one percent of all the water withdrawn in Montana. The water is heated and the resulting steam condenses in cooling towers that then cool the generators. The water is reused several times and then discharged.

Thermal Electric Power Generation in Montana

County	*Water Withdrawn (acre-feet)*	*Water Consumed (acre-feet)*	*Power Generated (megawatt hours)*
Dawson	18	0	43
Lincoln	12,836	0	25,000
Richland	34,331	0	330,000
Rosebud	7,091	7,091	4,289,000
Yellowstone	52,622	2,210	1,287,000
Total	***106,898***	***9,301***	***5,931,000***

Information in this table adapted from Water Use in Montana, 1980. 1986. Department of Natural Resources and Conservation

Instream Flows and the Fishery Resource

Trout fishing on the Big Hole, water skiing on Flathead Lake, floating down the "Mighty Mo." How would these pleasures be affected by lack of water? Although it is difficult to quantify in economic terms, water left in the stream is valued for providing water quality protection, habitat, fish spawning sites, and recreation.

Water quality depends on sufficient instream flows to help dilute pollutants such as arsenic from geothermal sources, toxic metals from inactive or abandoned mines, nutrients from treatment plants, and chemicals from agricultural areas. When water supplies are depleted, the concentration of pollutants can increase to levels harmful to aquatic organisms and to human health.

Adequate instream flows are also essential for providing habitat for aquatic animals of all kinds. During periods of low water, the temperature can increase beyond tolerable levels for many species. Low water levels also disrupt the feeding and nesting of water birds, the feeding and spawning of fish such as trout, and the movement of many kinds of fish.

Recreation and tourism also depend on good instream flows. Bumping over rocks in a canoe isn't nearly as fun as running rapids. Fishing is depressing when there are no fish. And few people want to risk their health by swimming in a polluted waterway.

The Montana legislature recognized the value of leaving water in streams for fish and wildlife purposes in 1969. That year, they passed an instream flow protection bill that allowed the Fish and Game Commission to file for what became known as *Murphy Rights* (named for the bill's sponsor) on the unappropriated waters of 12 *blue ribbon streams*. Although this legislation was repealed in 1973, the claimed appropriations remain valid.

In 1973, the Montana Water Use Act included a water reservation statute that set in motion a process to protect instream flows throughout the state. Reservations have been granted for 332 streams, including 249 streams in the upper Missouri basin, 18 streams in the lower Missouri, and 63 streams in the Yellowstone basin. Together with the Murphy rights claimed on 12 streams, a total of 344 streams in Montana have authorized instream flows. This amount comprises almost five percent of the streams in the state. Map D in the center section shows the location of these streams.

The Workings of a Multi-Purpose Reservoir

Exclusive flood control capacity
–Assigned for reducing flood damages downstream.

Joint-use capacity
–The part of the conservation capacity assigned to flood control and conservation during certain parts of the year.

Active conservation capacity
–The capacity used in regulating the reservoir for its many purposes (flood control, irrigation, recreation, etc.).

Inactive conservation capacity
–The reservoir capacity, exclusive of the dead capacity, that is needed to create flow for recommended discharges.

Dead capacity
–The reservoir capacity below which water cannot be evacuated by gravity.

Other Terms:

Surcharge capacity
–The capacity set aside strictly for collection of large flood inflows.

Replacement capacity
–The capacity set aside for replacing the space in a downstream reservoir.

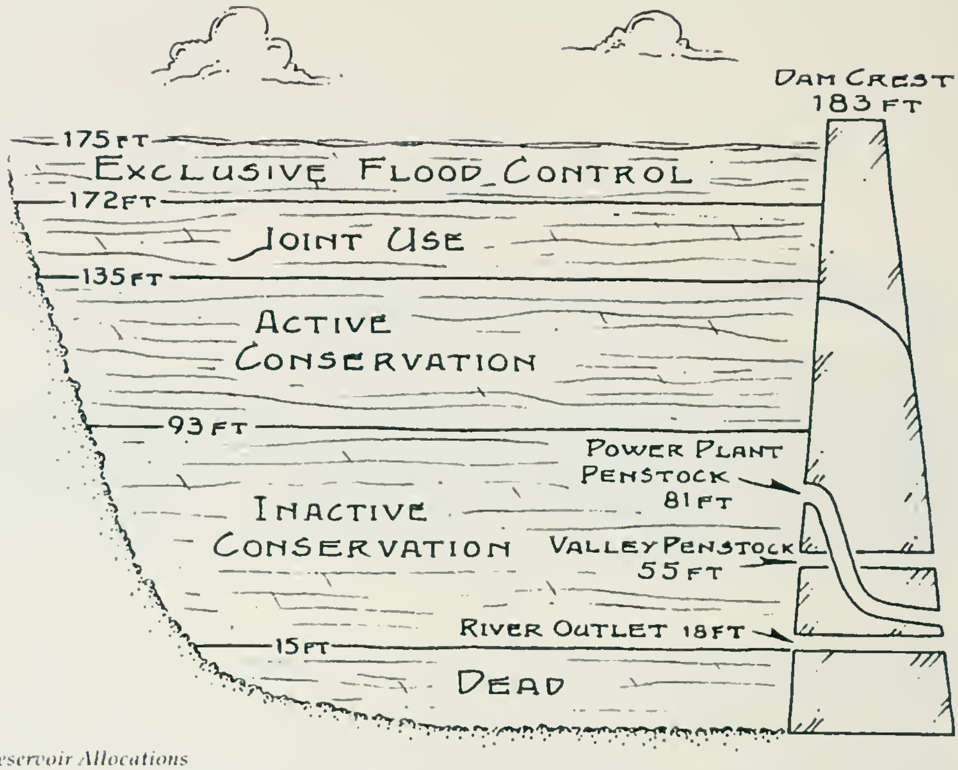
Total capacity
–The total volume of the water that can be impounded, exclusive of the surcharge capacity.

Live capacity
–The portion of the reservoir that can be withdrawn by gravity.

Murphy Rights

Murphy rights have a priority over other water uses until the district court determines that those waters are needed for a more beneficial use. The twelve Murphy streams are reaches of

- Big Spring Creek
- Blackfoot River
- Flathead River
- Middle Fork of the Flathead River
- North Fork of the Flathead River
- South Fork of the Flathead River
- Gallatin River
- Madison River
- Missouri River
- Rock Creek
- Smith River
- Yellowstone River



Reservoir Allocations
Water stored in a reservoir can take many paths. Montana's multipurpose reservoirs strive to meet the needs of flood control, hydroelectric generation, irrigation, recreation, fish and wildlife habitat, and municipal and industrial supply.

The level of protection these measures afford varies from stream to stream, and is always subject to the rights of prior appropriators. For example, all reservations in the upper Missouri basin have "no force and effect" for some uses due to legislative *basin closures*. (See Chapter 7 for more details about closures.)

Tourism and Quality of Life

Montana's pristine streams, rivers, and lakes provide the excellent quality of life enjoyed by everyone in the Big Sky state. Outstanding water quality and recreation opportunities also draw millions of visitors to Montana. For example, 2,300,000 state fishing licenses were sold during 1991-1992. In 1994, almost eight million tourists visited the state and expended $1.2 billion, making tourism the second-ranked revenue-producing industry in Montana. The 45,000 boats registered that year are another measure of the popularity of water-based recreation.

Although visitors also enjoy other aspects of Montana's landscape, we can be sure that water plays a major part in the travel, tourism, and recreation industries that serve these visitors, and that employ the 30,000 people who work in these fields. In addition, growth in the real estate and retirement industries also reflects how many people are searching for the quality living environments symbolized by Montana's clean water.

1993 Income Comparison of Montana Industries (in millions of dollars)	
Industry	*Income*
Agriculture	2,188
Travel/Recreation	1,245
Wood/Paper Products Manufacturing	910
Mining	787
Gas and Oil	431

Adapted from Montana Agricultural Statistics, 1994

[illegible] Dam near Great Falls on the Missouri. Photo courtesy Travel Montana

Appealing Fish

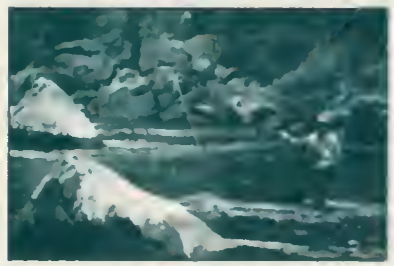
These are some of the cold water and warm water species that give Montana its special fishing appeal

Cold water species

- arctic grayling
- burbot
- kokanee salmon
- trout brook, brown, bull, golden, lake, rainbow, westslope cutthroat
- whitefish lake, mountain

Worm water species

- bass smallmouth, largemouth
- channel catfish
- crappie
- yellow perch
- northern pike
- paddlefish
- sauger
- shovelnose sturgeon
- walleye



[illegible]

For More Information

- Contact the Montana Department of Natural Resources and Conservation for water rights information.
- *Water Use in Montana,* 1980. 1986. Department of Natural Resources and Conservation.
- Montana Water Supply and Use. 1987. U.S. Geological Survey: National Water Summary.
- *Planning for an Irrigation System.* 1980. The American Association for Vocational Instructional Materials.
- *Montana Agricultural Statistics*. 1994. Montana Department of Agriculture.
- Natural Resources Information System. Montana State Library clearinghouse for water data.
- Contact the Bureau of Reclamation, Great Plains or Pacific Northwest Regions, for information on federal water projects and reservoir management.

4 Understanding Water Quality

Drinking Water Standards

Drinking water from a local public supply must meet federal and state standards for safe drinking water. Two sets of standards—primary drinking water and secondary drinking water—establish Maximum Contaminant Levels (MCLs) for a variety of contaminants. If the water supply exceeds MCLs for primary drinking water standards, it must be treated to eliminate the contaminant.

Primary drinking water standards establish concentration limits for contaminants affecting human health. Public water systems must meet the standards for microbes (coliform bacteria), inorganic contaminants (lead, arsenic, nitrates), synthetic organic chemicals (such as those in pesticides), and radionuclides (like radium 226).

Secondary drinking water standards set concentration limits for nuisance contaminants that affect color, odor, pH, clarity, and taste. Although it is desirable for drinking water to meet these secondary standards, it is not required by law.

A Century of Water Protection

In the early 1900s, good water quality meant water was free from the microorganisms that make people ill. Typhoid fever was rampant in Montana because many towns released untreated sewage into the streams and irrigation ditches that supplied their drinking water. The Montana legislature responded to this health hazard by passing the state's first stream pollution law in 1907. The law prohibited the release of raw sewage and other pollutants into surface waters used for drinking, ice supply, and other domestic purposes. It also required every city to construct a sewage treatment works. Amendments in 1929 set out to improve water quality for gardening, crop production, and domestic animals.

In the following decades, many other important acts expanded water quality protection. The Montana Water Pollution Control Act of 1955 established a stream classification system based on actual and anticipated uses. The 1972 Montana Water Quality Act set goals to:

> ...conserve water by protecting, maintaining, and improving the quality and potability of water for public water supplies, wildlife, fish and aquatic life, agriculture, industry, recreation and other beneficial uses and provide a comprehensive program for prevention, abatement, and control of water pollution.

With this landmark legislation, Montana's concept of water quality expanded to support other uses of water, including healthy habitats for plants and animals in lakes and streams.

Water Quality Today

Today, we can define water quality according to the amount and kind of substances present in water, by water's ability to support beneficial uses such as irrigation and recreation, and by the overall health of the aquatic ecosystem.

One way that we assess water quality is by measuring contaminants that originate from natural or human-made sources. Some of these contaminants often escape detection except through laboratory tests. The list includes:

- **chemical** contaminants such as petroleum products from fuel leaks; metals like copper, zinc, cadmium, lead, and arsenic from mine wastes and natural sources; and phosphorus and nitrogen from fertilizers and sewage;
- **physical** contaminants such as turbidity, taste, temperature, sediment, color, and odor;
- **biological** contaminants such as fecal coliform bacteria from human or animal wastes;
- **radiological** contaminants such as radon or uranium mill wastes

To assure that our drinking water is safe, federal and state governments established standards that regulate contaminants affecting public health and the aesthetic quality of water.

We can also assess water quality by its ability to support its intended *beneficial use*, such as irrigation, industrial use, fish propagation, or recreation. For example, low instream flows can be considered a water quality problem if they impact trout spawning or survival. Laws have been passed in Montana to protect these beneficial uses.

Water quality also reflects the overall health of aquatic ecosystems. The health of lakes, streams, and wetlands is measured by the constituents dissolved in the water, the condition of the banks, shoreline, and riparian zones *(habitat)*, and the composition of the plants and animals living in the water *(biological integrity)*. As a rule, healthy aquatic ecosystems produce good quality waters unless compromised by *habitat modification*.

How Clean is Montana's Water?

Montana's waters exhibit natural extremes in quality, ranging from near pure water in some western headwater lakes and streams to the salinity of sea water in a few seeps and ponds in eastern Montana. We impair the quality of these waters through our daily activities, which can cause pollution from a variety of point sources or nonpoint sources.

Point source pollution comes from a localized discharge into a lake, stream, or ground water. This type of pollution accounts for ten percent of water impairment in Montana. Common point sources for surface water pollution include industrial and municipal wastewater discharges. Municipal discharges often contain contaminants that we flush down the toilet or dump down the drain. Point sources such as leaking underground fuel storage tanks and landfills contribute to ground water pollution. Most point sources of pollution are regulated by discharge permits mandated by federal and state law.

Nonpoint source pollution originates from activities over a broad area of land. Nonpoint sources include agricultural and forest practices, river channel modification, urban development, and mining. These sources contribute pollutants such as

[illegible] Montana Department of Environmental Quality.

Habitat Modification and Water Quality

When we modify habitats by activities such as bulldozing streambeds to divert water, we are affecting the *riparian zone* and the integrity of the stream channel. These modifications can cause erosion, destroy aquatic habitats, increase water temperature, and alter stream flows and lake levels. Habitat modification also promotes nuisance plant growth, degrades aesthetics and fish production, and generates byproducts that make water unfit for use and more expensive to treat. Because of the drastic effects caused by habitat modification, many such practices are no longer allowed on Montana's waterways. Before you attempt to modify riparian habitat, be sure to consult with your local Conservation District.

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Runoff

Runoff flows to streams and lakes, or infiltrates to ground water during a storm event or spring thaw. As it races across the land, runoff collects pollutants such as sediment, trace metals, bacteria, and nutrients. In cities and towns, drains capture storm water and often carry it directly to nearby waterways.

Superfund

Motivated by the contamination of ground water at Love Canal in Buffalo, New York, Congress passed the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) in 1980. CERCLA makes polluters responsible and liable for damages to the environment and human health. It creates measures to clean up uncontrolled hazardous waste sites such as landfills, hard rock mines, wood treatment plants.

The "Superfund" is a trust fund that makes money available for clean-up of hazardous waste, where there is no responsible party. The Superfund National Priority sites list includes eight sites in Montana. The largest complex of sites—both in Montana and in the nation—is along The Clark Fork of the Columbia River, from Silver Bow Creek at Butte to Milltown Dam near Missoula. Seepage from old tailings and discharge from inactive and abandoned mines contaminates streams and aquifers in this area of Montana.

Montana's counterpart to the federal CERCLA law, the Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA), was passed in 1989. It mandates cleanup for 250 sites not on the federal priority list.

sediments, metals, nutrients, mineral salts, and pesticides. Stormwater runoff collects nonpoint source contaminants as it flows down streets and across other impermeable surfaces.

When you add up the amount of all of the nonpoint sources, they account for 90 percent of Montana's water impairment. The state takes a non-regulatory approach to solving these problems by relying on land owners and managers to voluntarily implement *best management practices (BMPs).*

Not all water quality impairment is caused by human activity. Materials released naturally from geologic materials can also influence water quality. For example, arsenic occurs naturally in the geothermal features of Yellowstone National Park and affects water quality downstream in the Yellowstone, Madison, and Missouri rivers.

To better protect water from all types of pollutants, the state of Montana established a classification system for its waters. Surface waters were classified in 1955 according to actual and anticipated uses into four categories (A, B, C, and I) based on water temperature, ability to sustain fish and aquatic life, and suitability for other uses. Map E in the center section locates waters in these categories. Ground water was classified into four groups based on quality and use as of October, 1982: Class I, suitable for public and private water supply with little or no treatment; Class IV, suitable only for some industrial and commercial uses.

How Clean Are Streams?

Based on a study by the Montana Department of Environmental Quality, in 1994 more than 14,000 miles of streams in Montana were assessed as threatened or impaired. This represents almost one quarter of the 53,000 *perennial* stream miles in the state—and it is not a complete assessment. Reliable information exists only for major streams and those with known or suspected problems.

The major sources of stream impairment include:

- irrigation return flows
- dewatering
- mismanagement of stream banks and riparian zones through overgrazing, logging, and road construction
- discharges from municipal wastewater treatment plants
- mining

How Clean Are Lakes?

About 800,000 of Montana's 833,964 lake and reservoir acres have been assessed. Due to water level fluctuations, only 14 percent of lake acres assessed in Montana fully support fish and aquatic life. More than half support swimming and drinking water uses.

The main sources of lake impairment are:

- agricultural practices
- natural chemicals such as arsenic
- dam operations that can lead to fluctuating water levels
- municipal sewage plants
- septic systems
- air pollution
- forest practices

Contamination of lake waters can elevate salinity, nutrients, suspended solids, siltation, organic enrichment, metals, and promote noxious aquatic plant growth. To begin repairing the impairment of lakes, communities—particularly Flathead and Missoula counties—have passed local shore-line protection ordinances and phosphate bans.

How Clean Is Ground Water?

Human activities contribute the major sources of ground water contamination, especially in urban areas. These sources include:

- petroleum spills and leaking underground storage tanks. About 22,500 underground storage tanks are registered with the state. A pinhole leak from just one of these tanks can spill 500 gallons of fuel each year. Thousands of gallons of diesel fuel have spilled beneath major fueling facilities over a 75-year period.
- injection wells and runoff from storm drains, which add organic contaminants to ground water. About 900 oil field injection wells and thousands of shallow injection wells (like those in car washes and auto shops) exist in Montana.
- improperly designed sewage disposal and septic systems, which can contaminate ground water with coliform and other bacteria, viruses, and nutrients.
- leaching of contaminants from solid waste landfills and hazardous waste storage and disposal sites. Thirty years ago, 500 landfills were scattered around Montana. Today, landfills centralize waste disposal under highly regulated conditions. About 32 active Class II municipal solid waste landfills accept mixed wastes, including certain household hazardous wastes; 50 Class III landfills accept non-water soluble items such as tires, brush, and brick; and 12 privately-operated Treatment, Storage, and Disposal (TSDs) facilities handle hazardous waste. Substances that can pollute ground water at all of these landfill sites include metals, solvents, refrigerants, and petroleum derivatives.
- sludges from petroleum refining, creosote and solvents from wood treatment, and pesticides from agricultural and domestic insect control.
- contamination at hard rock mining operations from disposed tailings, cyanide heap leach facilities, and spills and leaks. Fluids from these sources may contain cyanide, heavy metals, inorganic chemicals, and very acidic water.
- oil and gas exploration, which uses drilling fluids containing diesel fuel and salts, has contaminated some domestic water supplies and surface soils in eastern Montana.
- agricultural practices, resulting sometimes in saline seep and nutrient-rich runoff.
- geology and natural substances. Ground water that migrates through rock formations can dissolve some minerals present in the rocks. The ground water near mineral deposits in western mining districts often contains heavy metals. Ground water that flows through fine-grained rocks in eastern Montana often exceeds the standard of 500 mg/L for total dissolved solids because salts and minerals dissolve in the water.

How You Can Protect Water Quality

Ground and surface waters are closely connected. When we pollute or deplete one, it affects the other, despite the fact that we are often unaware of the impacts. That's why individuals are becoming personally involved in pollution abatement and prevention, far beyond what a myriad of laws require of us. (These laws are described in Chapter 6.) Individually we can arrest the pollution problem by simply reducing the number of pollutants we pour down the drain, conserving water in our homes and

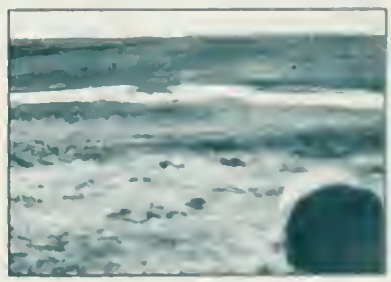
Saline Seep

Soil salinity is a problem that has intensified with agricultural development during the last 40 years. About 300,000 acres of formerly productive cropland in Montana are no longer able to produce crops because of salinity.

The problem can be linked to crop-fallow dry land farming practices that have replaced native rangeland. How has this occurred? More water is received from rain and snow in the 14 to 21 month fallow period than can be stored in the rooting zone. Consequently, downward movement of natural salts, nitrates, and trace elements occurs through the soil. This movement increases during wet periods when no crop is actively growing. As the salty water approaches seepage spots on the soil surface at lower elevations, it evaporates and leaves salt that can kill crops and render the soil and water unusable.

Saline ground water is dominated by calcium, magnesium, and sodium sulfate salts, ranging from 500 to 72,000 mg/L total dissolved solids (TDS). The recommended upper levels for TDS are 500 mg/L for domestic uses, 1,000 mg/L for irrigation, and 3,000 mg/L for livestock water. Sea water is about 35,000 mg/L TDS.

If saline seep is a problem, the Montana Salinity Control Association or other groups conduct agronomic and hydro-geologic assessments, then develop management strategies such as planting deep-rooted crops and using intensive annual cropping practices in upslope recharge areas.



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When I Test My Well, Spring, or Tap Water, What Will I Learn?

When you have your water tested, you are paying for an analysis that includes information about:

Total dissolved solids (TDS)
A measure of all dissolved minerals in solution (also called salinity, salt content, total mineral content, or alkali content). TDS typically ranges from fewer than 2 mg/L for distilled water to more than 20,000 mg/L for highly saline waters. TDS affects taste, clarity of water, and pipe corrosion. (The Maximum Contaminant Level is 500 mg/L.)

Nitrates
Levels greater than 10 mg/L pose an immediate threat of blood poisoning (methemoglobinemia) to infants under six months of age. Nitrate in well water may indicate contamination from agricultural practices or septic systems.

Hardness
The presence of calcium and magnesium ions that react with soap to form precipitates such as bathtub rings. A value of less than 25 mg/L is considered soft (rainwater); and values above 250 mg/L are considered very hard and require large amounts of soap to produce suds.

Alkalinity (pH)
The measure of water's capacity to neutralize acids. The acceptable alkalinity for municipal supplies is between 30 and 500 mg/L $CaCO_3$. Taste may be objectionable above 500 mg/L.

Lead
Drinking water may contain lead from soldered joints or old lead pipes. The current acceptable level is 0.015 mg/L.

Arsenic
Frequently found near mineralized areas and hot springs. The Environmental Protection Agency has set a limit of 0.050 mg/L in public drinking water supplies.

Iron
More than about 0.3 mg/L stains laundry and utensils reddish brown. Higher levels can cause unpleasant taste and aid growth of iron bacteria. Excessive iron may interfere with effectiveness of certain water softeners.

Coliform bacteria
Generally are not harmful themselves but indicate that other harmful organisms may be present in water—typhoid, cholera, infectious hepatitis, parasitic protozoans.

businesses, and decreasing toxic chemical use in gardens and lawns. Other simple things that you can do to protect the integrity of water include the following.

1. **Use best management practices (BMPs)** at the ranch or in small industry. For example, establish vegetation along stream banks to trap pollution from runoff; locate corrals, septic systems, and areas of heavy irrigation, pesticide use, and herbicide use away from streams, lakes, and wells.
2. **Properly dispose of chemicals** (pesticides, solvents, fertilizers, paint), and other toxic substances—and **use less**. Do not dump these substances on the ground outside homes or down the drain for treatment by a septic system or municipal wastewater treatment facility. Dispose of them at a TSD facility (a permitted hazardous waste disposal site), at a Class II landfill that can accept household hazardous wastes, or at an appropriate recycling facility. Better still, purchase only the amount of these substances needed or give the remainder to a friend who can use them up. Some towns have conducted household hazardous waste collections and paint swaps. These simple procedures save tax dollars that might be needed to clean up a bigger problem later.
3. **Use phosphate-free products** whenever possible. Build-up of phosphorus in lakes and streams can lead to overgrowth of algae and eutrophication (aquatic plant overgrowth).
4. **Conserve water** wherever possible. For example, plant native species that are naturally drought-resistant in your lawn and garden. (This is known as xeriscaping.) Conservation saves water and reduces the amount of wastewater you produce. This, in turn, prevents wear and tear on septic systems and municipal wastewater treatment plants. Conservation also reduces your water bill and can help ensure availability of water for other uses.
5. **Recycle** everything you can. Thirty-four community recycling centers across Montana accept newspaper, cardboard, aluminum, glass, plastics, and reuseables. Recycling places less stress on landfills and, in the long run, promotes the sustainable use of natural resources (trees, water, minerals). You can help further by purchasing products with minimum packaging that consume fewer resources.
6. **Analyze the water.** If your drinking water comes from a private well or if your home is old or has deteriorating pipes, you may want to have your water tested to be sure that it is suitable for drinking, bathing, washing, and cooking. Types of tests and costs vary.

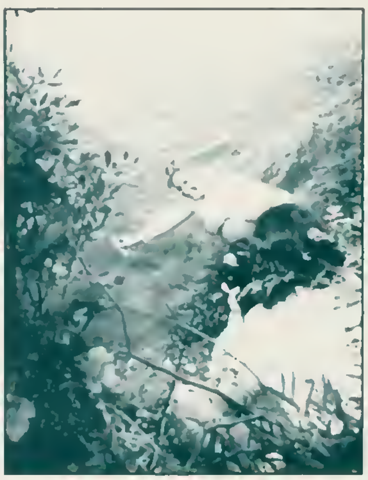
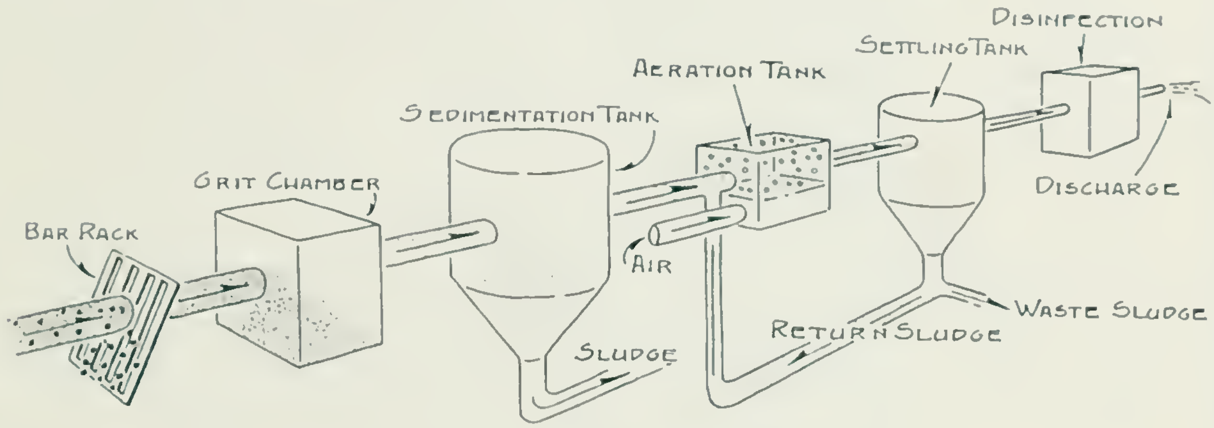


Photo courtesy Mary Ellen Wolfe

Wastewater Treatment: From Flush to Streamflow

Most of the water that we use reenters the environment, either by direct discharge to streams or by introduction into the ground water. Each person who draws water from the public water supplies uses an average of about 140 gallons of water per day (including commercial and parkland uses). Approximately 126 of those gallons wind up back in ground or surface waters as industrial or domestic wastewater.

Montana communities collect and treat wastewater from residences and businesses at centralized municipal treatment facilities. Of Montana's 165 wastewater treatment plants, 143 are lagoon plants. The rest are mechanical plants, requiring special equipment to treat the wastes prior to discharge. Homes not served by wastewater treatment plants have on-site disposal such as septic tanks with drain fields.



Septic Systems

Rural residents usually have on-site septic tanks. Septic systems typically consist of a septic tank and a soil drain field. The septic tank breaks down and liquefies organic material and stores non-biodegradables. The drain field treats the liquid effluent by further filtering out particles and breaking them down with soil bacteria.

Approximately 120,000 individual on-site septic systems are used by 300,000 people in Montana. When maintained properly, septic tanks provide adequate treatment. However, if too many septic systems are sited in one area, they can contaminate surface and ground water with bacteria and nutrients.

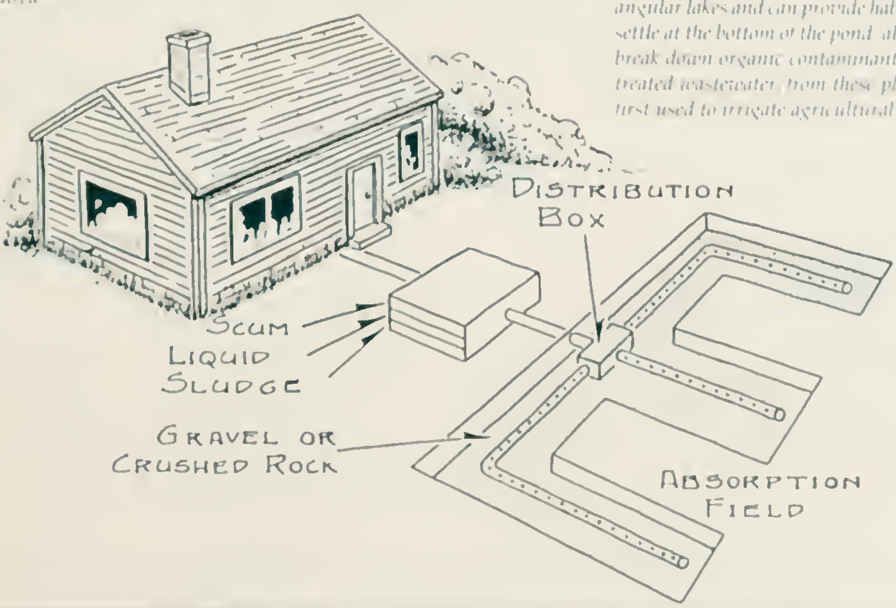
Nitrate is a common contaminant originating from septic systems. Nitrates can also come from fertilizers used on residential lawns and farmlands. When infants drink water with nitrate concentration exceeding the Maximum Contaminant Level of 10 mg/L, their circulatory system's ability to transport oxygen is impaired.

Mechanical Treatment

Larger communities treat wastewater in mechanical treatment plants that use biological processes to maximize treatment. The process typically begins with primary treatment to settle out large materials. Secondary treatment uses microorganisms to convert the remaining dissolved and suspended biodegradable organic wastes into a sludge. This stage usually includes trickling filters, activated sludge, and clarification, often followed by disinfection (ultraviolet or chlorination). Advanced treatment is more expensive but removes most additional nutrients. The Flathead basin is the only drainage in Montana where advanced treatment is required of all municipal wastewater discharges. Water quality standards determine the degree of treatment needed to insure adequate protection of public health and the environment before a waste is discharged.

Lagoon Treatment

Smaller communities use lagoon treatment systems, which often look like rectangular lakes and can provide habitat for ducks and other wildlife. While solids settle at the bottom of the pond, algae produce the oxygen needed by bacteria to break down organic contaminants in the wastewater. Most of the effluent (or treated wastewater) from these plants is returned to the environment, or it is first used to irrigate agricultural land, golf courses, parks, and other areas.

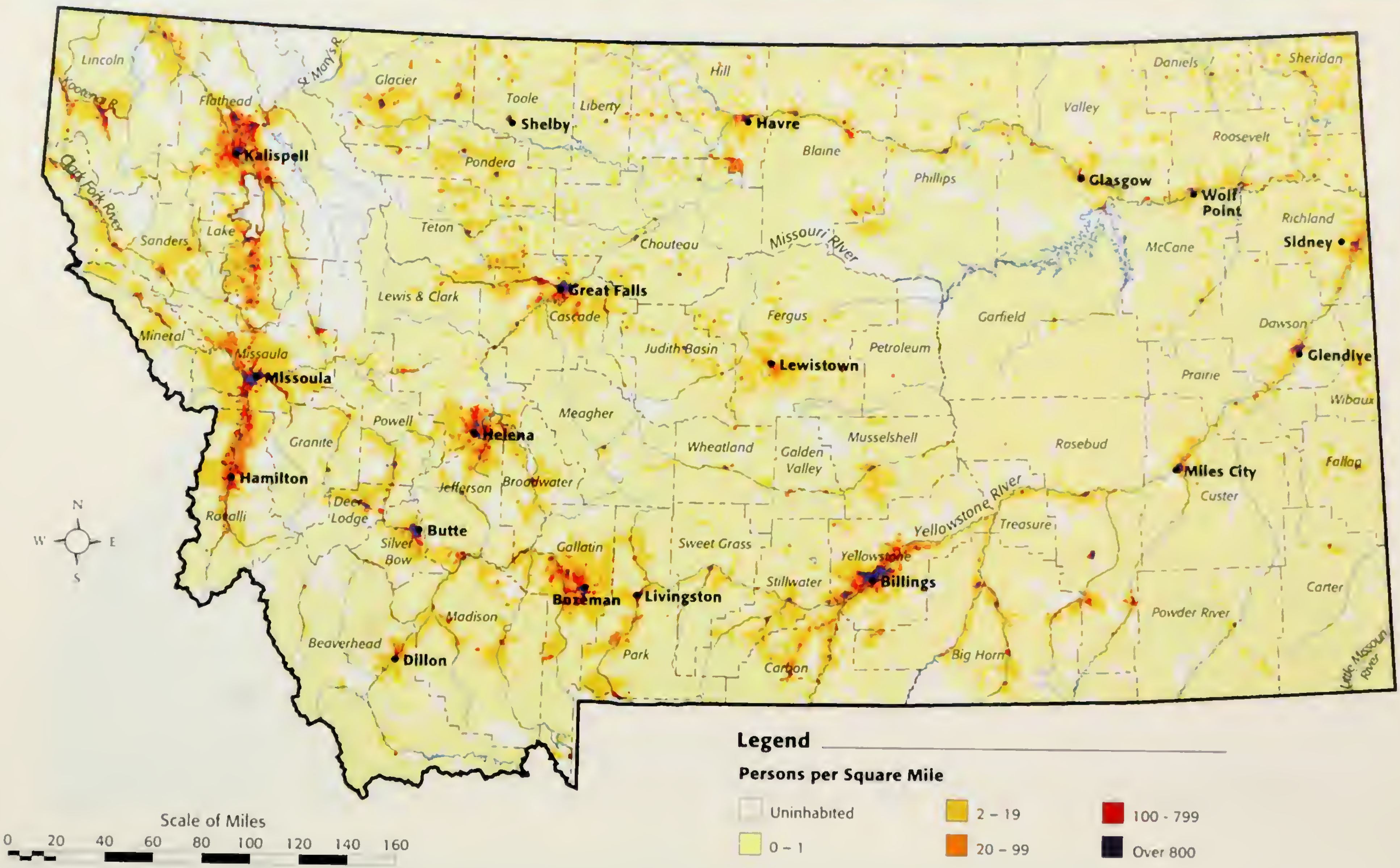


For More Information

- Contact:
  - —Montana Department of Environmental Quality.
  - —U. S. Environmental Protection Agency.
  - —Montana State University Extension or your local Extension agent.
  - —Your local conservation district office, health department, or landfill.
  - —Montana Department of Environmental Quality Waste Management Division, the Montana State University Extension Service Pollution Prevention Control Program, the Montana Material Exchange, or your county sanitarian for more information on proper disposal of hazardous wastes.
  - —Department of Environmental Quality or a reputable local water testing lab to find out how to collect and submit a water sample.
- *Water Quality: A Matter of Choice*, Montana State University Extension Service, Pub. EB48A, 48B
- *Montana Water Quality 1994*. Montana Department of Environmental Quality.
- *Common Sense and Water Quality: A Handbook For Livestock Producers.* 1994. Montana Department of Environmental Quality.
- *Tips on Land and Water Management for Small Farms and Ranches in Montana*, Montana Department of Natural Resources and Conservation.
- *1995 Montana Recycling Directory*. Keep Montana Clean and Beautiful.
- *Onsite Wastewater Management Options for Montana Businesses*. MSU Extension Service.
- *A Catalog of Water Conservation Resources*. The Montana Watercourse, MSU–Bozeman.
- *Who Does What With Montana's Water: A Directory.* 1995. The Montana University System Water Resources Center and The Montana Watercourse.

Map A

Montana Population Density



Legend

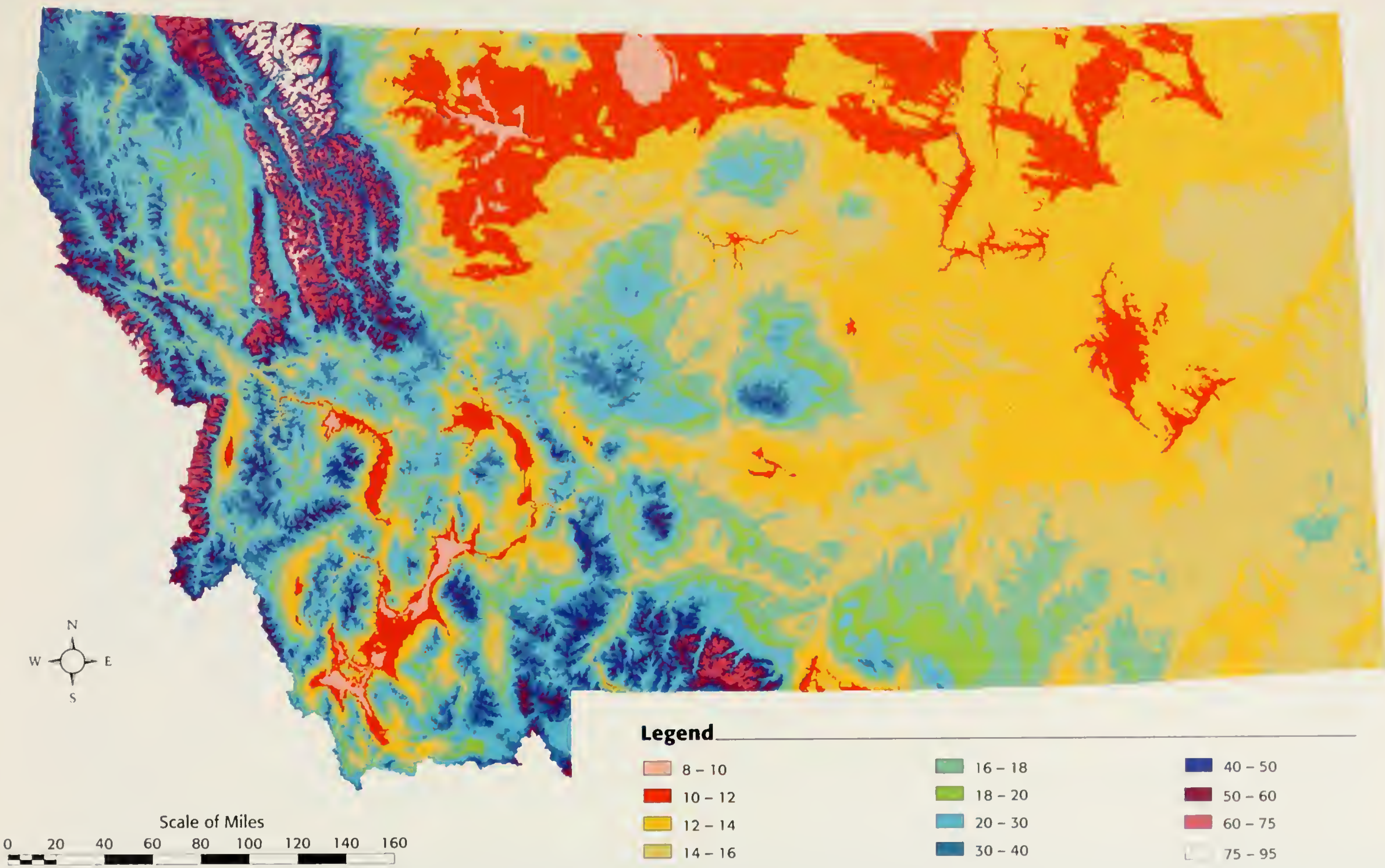
Persons per Square Mile

- Uninhabited
- 0 – 1
- 2 – 19
- 20 – 99
- 100 - 799
- Over 800

Map compiled by Natural Resource Information System, State Library, using 1990 census data provided by the U.S. Department of Commerce

Map B

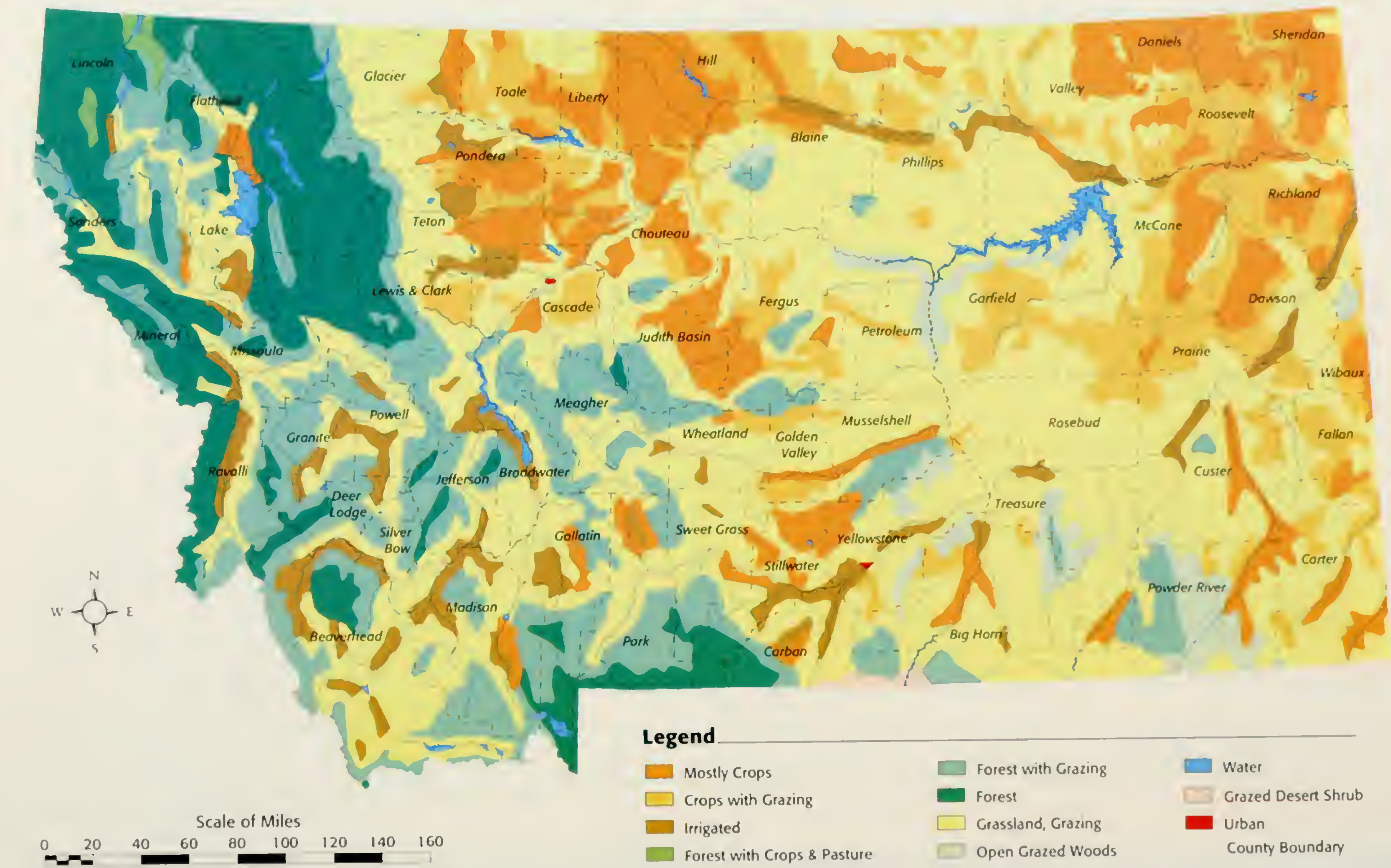
Montana Mean Annual Precipitation in Inches



Map and data provided by the Geographic Information Analysis Center, MSU.

Map C

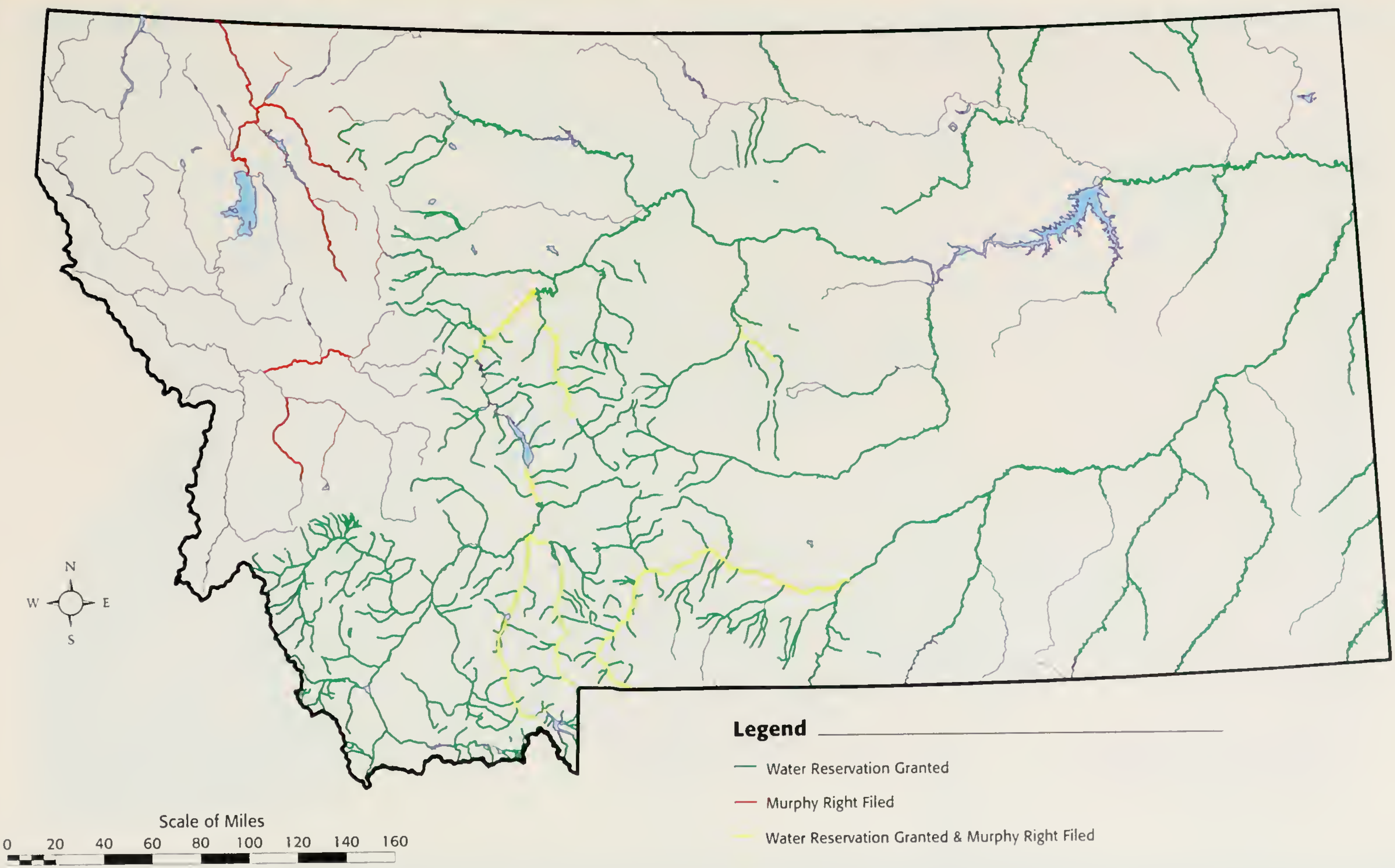
Montana Land Use



Map composed by Natural Resource Information System, State Library, with data provided by U S Geological Survey

Map D

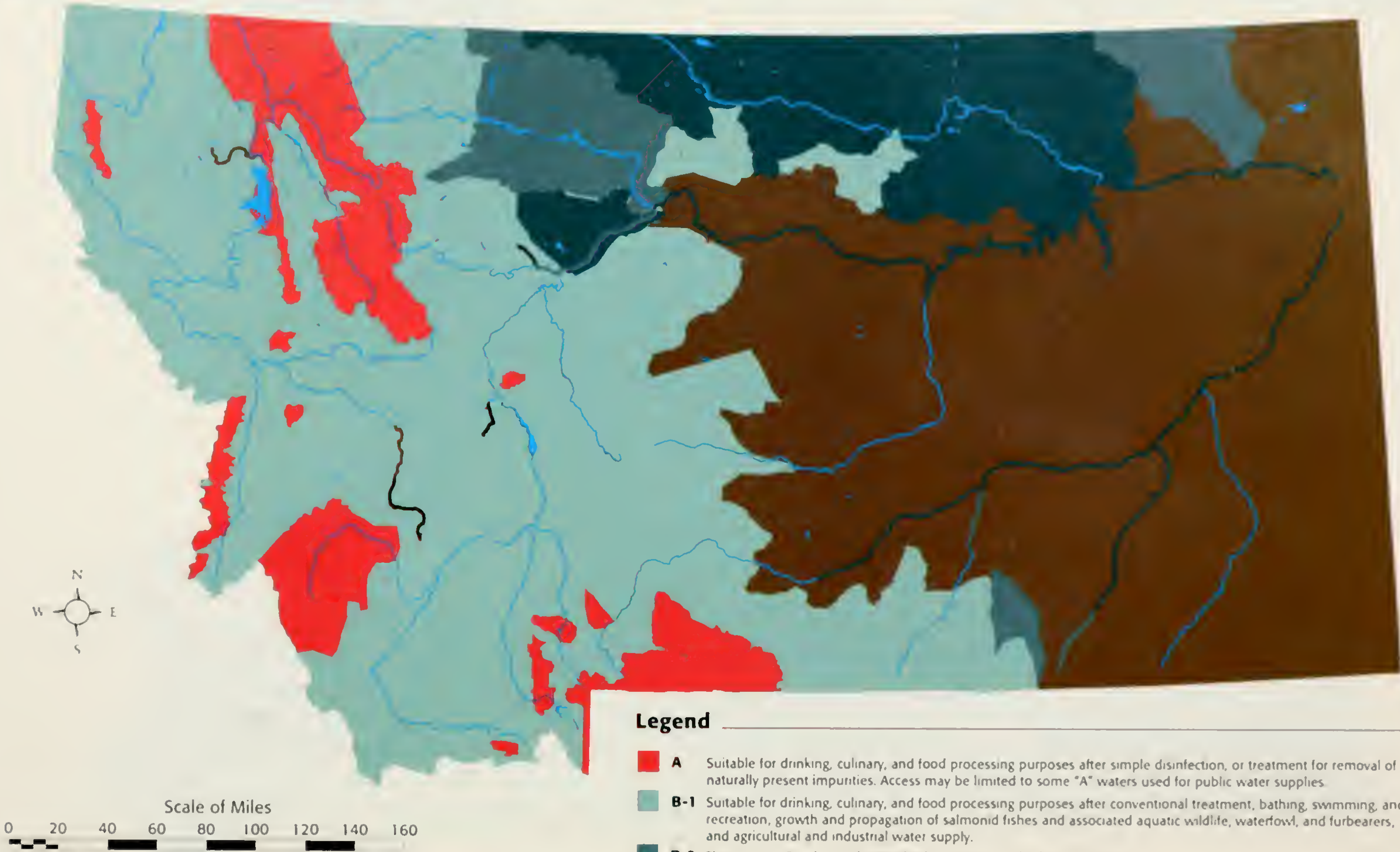
Montana River Reaches with Protected Instream Flows*



*These reaches equal slightly less than 5 percent of Montana's total stream miles.
Map and data provided by the Montana Department of Fish, Wildlife and Parks.

Map E

Montana Surface Water Quality Classifications*



Legend

- **A** Suitable for drinking, culinary, and food processing purposes after simple disinfection, or treatment for removal of naturally present impurities. Access may be limited to some "A" waters used for public water supplies.
- **B-1** Suitable for drinking, culinary, and food processing purposes after conventional treatment, bathing, swimming, and recreation, growth and propagation of salmonid fishes and associated aquatic wildlife, waterfowl, and furbearers, and agricultural and industrial water supply.
- **B-2** The same as B-1, but with **marginal** propagation of salmonid fishes.
- **B-3** The same as B-1, but with growth and propagation of **non**-salmonid fishes
- **C** Suitable for bathing, swimming, and recreation, growth and propagation of salmonid or non-salmonid fishes and associated aquatic wildlife, waterfowl, and furbearers, and agricultural and industrial water supply
- **I** Greatly impacted streams not currently supporting the uses listed above. They include reaches of Prickly Pear, Silver Bow, and Muddy Creeks

*Exceptions to these use classifications exist. Complete identification of a waterbody's use classification can be found in Montana A.R.M. 16.20.604 through 16.20.612

Map composed by the Natural Resource Information System, State Library, with data provided by the Montana Department of Environmental Quality

Map F

Missouri River Basin

*The 1992 Natural Resources Inventory (USDA, Natural Resources Conservation Services) estimate 3 percent of this basin as irrigated.
Map compiled by Natural Resources Information System, with data from several sources. Design and layout by Palmquist & Palmquist Design.

Map G

Yellowstone River Basin

*The 1992 Natural Resources Inventory (USDA Natural Resources Conservation Service) estimates 3 percent of the basin as irrigated.
Map compiled by Natural Resource Information System, with data from several sources. Design and layout by Palmquist & Palmquist Design.

Map H

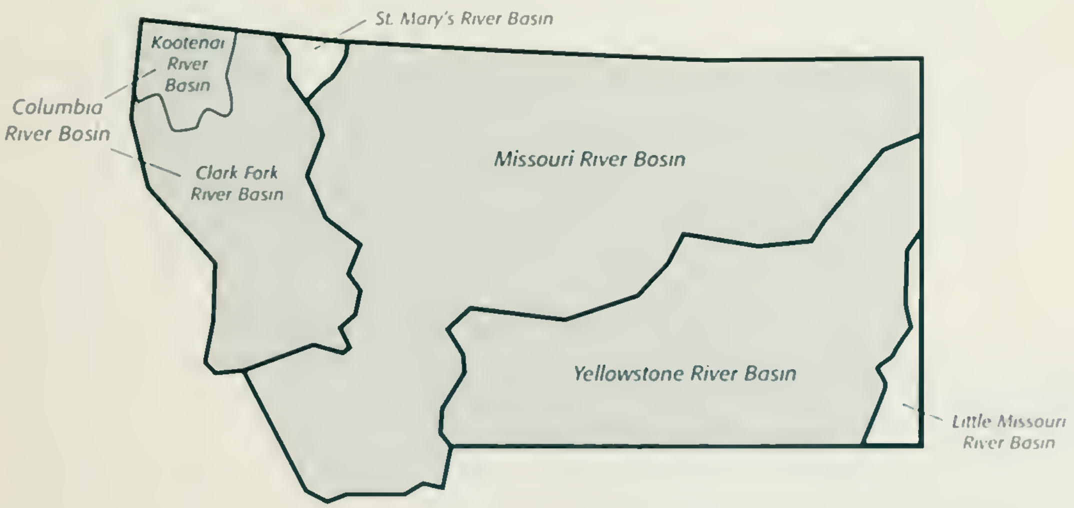
Columbia River Basin

*The 1992 Natural Resources Inventory (USDA, Natural Resources Conservation Service) estimates 4 percent of this basin as irrigated.
Map compiled by Natural Resource Information System, with data from several sources. Design and layout by Palmquist & Palmquist Design.

5 Watershed Profiles

Montana contains the headwaters for three continental watersheds—the St. Mary's River, the Columbia River, and the Missouri River. The St. Mary's drains only a small portion of the state. The major watersheds of Montana are those carved by the Columbia River's tributaries, the Missouri River, and the Yellowstone River. (The Yellowstone basin is considered separately from the Missouri watershed because their rivers merge outside the state.)

In this chapter we profile these three major watersheds. As you read, refer to the three basin maps located in the center pages of this guide (Maps F, G, and H.) Each map displays symbols indicating major uses of or impacts to water: cities, irrigated lands, sites with wastewater discharge permits, operating mines, hydroelectric dams, and thermoelectric plants.



Missouri River Basin

The Missouri River basin—the largest in Montana—drains more than one half of the state's land area, but yields less than one-fifth of the water. The river rises in southwestern Montana from the confluence of the Madison, Jefferson, and Gallatin rivers near Three Forks. It flows north, then bends east at Great Falls, and exits the state 400 miles downstream near Fairview. Major tributaries include the Big Hole, Dearborn, Judith, Marias, Milk, Musselshell, Smith, Sun, and Teton rivers.

Fifty reservoirs in the basin each have a capacity of 5,000 acre-feet or more. Fort Peck Reservoir is a huge multi-purpose project constructed on the Missouri River by the federal government beginning in 1933. It normally stores 15 million acre-feet but has a capacity of more than 19 million acre-feet—which makes it one of the largest reservoirs in the United States.

Water Use

In the Missouri River basin, irrigation is the major offstream use of water. Surface water from the major tributaries irrigates almost one and a half million acres of alfalfa, pasture, wheat, and barley. Where surface water is unavailable, ranchers pump ground water for their livestock watering and other agricultural needs.

Municipal drinking water systems use only about 1.5 percent of the water consumed in the basin, but they provide water for more than 275,000 people. This public water supply draws from both surface and ground water. Most rural residents rely solely on ground water for their domestic needs. Instream flows support electrical generation, fisheries, and recreation. Ten percent of Montana's electrical generating capacity comes from hydroelectric facilities along the Missouri and its tributaries.

The entire length of the Madison, and parts of the West Gallatin and Missouri are rated as Class I fisheries for trout. The lower Missouri is also rated Class I for paddlefish and sturgeon. Reservoirs in the north and east support excellent walleye and northern pike fisheries—and recreational pursuits such as boating, wind-sailing, and wildlife watching. You can float 207 miles from Montana Power Company's Morony Dam to Fort Peck Reservoir without encountering another dam. In 1976, Congress designated 149 miles of this stretch as a national Wild and Scenic River.

Water Quality

Water quality within the Missouri River basin varies from excellent to highly impaired. Generally, surface-water quality is good in the upper basin. Exceptions include stretches of the Madison and upper Missouri that contain arsenic from geothermal features in Yellowstone National Park and surrounding areas. Smaller tributaries also experience quality impairment during periods of low flow in the late summer. Water quality degrades downstream as salts, nutrients, sediment, and temperature increase due to land use practices.

Ground-water quality generally is good in alluvial aquifers along major streams and in deeper bedrock aquifers near the mountains. Quality decreases in bedrock aquifers that are farther from mountains because they are recharged more slowly. The longer that water resides in bedrock, the higher its concentrations of contaminants such as solids, sulfate, iron, fluoride, nitrogen, and trace elements. Other ground-water impairment occurs due to saline seep from some agricultural practices, arsenic and sulfate from smelting operations, pentachlorophenol (PCBs) from wood treatment practices, petroleum from leaking underground storage tanks, and chemicals from the over-application of agricultural products.

Fort Peck Reservoir, the site of the Charles M. Russell National Wildlife Refuge, is a popular retreat, as is Canyon Ferry Reservoir, the most heavily used water recreation area in Montana. Photo courtesy Travel Montana Department of Commerce

Water Use in the Missouri River basin, 1980 (includes St. Mary's Drainage)	Withdrawn (1,000 acre-ft/year)	Consumed (1,000 acre-feet/year)
Hydroelectric Power Generation	37,264	0*
Thermoelectric Power Generation	0	0
Self-supplied Industry	3	1
Municipal	71	25
Rural Domestic	7	7
Irrigation	7,902	1,744
Livestock	16	16
Basin Total	***45,263***	***1,793***

These figures assume all water passing through turbines is returned to the river downstream, they don't reflect the fact that evaporation from reservoirs contributes greatly to consumptive losses

Issues and Concerns in the Missouri Basin

- **Whirling disease,** a natural parasite that weakens and kills rainbow trout and some other fish species, was first detected in the Madison River. It has been seen in other drainages east and west of the Continental Divide. A task force of agencies is monitoring the problem.
- **Arsenic** occurs naturally in the Madison River and exceeds the drinking water standards at times in the Missouri upstream of Canyon Ferry. The Montana Department of Environmental Quality monitors arsenic levels.
- **Water supply** does not satisfy all demands in many sub-basins. In particular, the Ruby, Jefferson, Gallatin, and Big Hole Rivers suffer from seasonal dewatering problems. Management plans that set reservoir and stream levels and basin closures address this issue. (See Chapter 7.)
- Some species of **fish are in decline.** The pallid sturgeon in the lower Missouri, listed as a federal endangered species, is declining due to low water flow and high water temperatures. Arctic grayling in the upper Big Hole, described as a species of special concern, is affected by critical low flows during the spawning season.
- **Water rights** at large-scale dams have not yet been settled by the courts. As a result, no one knows exactly how much water will be available downstream for offstream or instream uses.
- **The 1976 federal designation** of part of the Missouri as a national Wild and Scenic River raises questions about how much water is associated with this federal right. The State of Montana is negotiating the amount with the Bureau of Land Management.
- **Reserved water rights** are being quantified with tribes on the Blackfeet, Fort Belknap, and Rocky Boy reservations. Reserved rights have been negotiated already on the Fort Peck reservation.
- **Flow and water level fluctuations** required by nine privately-owned hydropower dams in the upper Missouri basin can affect water temperature, aquatic habitat, shoreline erosion, and the river's ability to transport toxic metals from tributaries. An interagency committee is proposing new stipulations for operating conditions during the Federal Energy Regulatory Commission relicensing process.
- **Heavy sediment load** from irrigation runoff affects water quality in the Muddy Creek, and in the Sun and Missouri Rivers that it feeds. After years of study, a citizen's task force has begun to implement solutions.
- **Fort Peck Reservoir levels** have been considerably lower over the last five years, causing an impact on the recreation industry. This is an interstate issue addressed in the Corps of Engineers' Master Manual.

Yellowstone River. Photo courtesy Marypat Zitzer

Yellowstone River Basin

The Yellowstone River is free of dams for its entire 671 miles, making it the longest free-flowing river in the lower 48 United States. Its headwaters originate in Wyoming and Montana, and its huge watershed drains one-third of Montana. The river winds north through mountains, then turns east at Livingston, flows through Billings, and meanders through flatter eastern Montana before joining the Missouri just beyond the state boundary. Basin elevations range from Granite Peak (12,799 feet) in the Beartooth Mountains to about 2,000 feet near Sidney, where the Yellowstone exits the state. Tributaries include the Bighorn, Boulder, Clark's Fork, Powder, Shields, Stillwater, and Tongue rivers.

The Yellowstone River basin includes areas of high annual precipitation and snowpack in the upper basin. It also embraces Montana's driest valley, the Clark's Fork of the Yellowstone near Belfry, that receives six inches of precipitation each year.

Surface water of the basin is collected in reservoirs, seven of which exceed a 5,000 acre-feet capacity. The largest is Bighorn Lake, a multipurpose reservoir on the Bighorn River.

Water Use

Irrigation is the major offstream use of water in the Yellowstone River basin. Water from tributaries irrigates more than 680,000 acres. Ground water, found in both near-surface and deep aquifers, irrigates a small proportion of the agricultural land and provides an important source of water for livestock.

Municipal water supplies also consume surface and ground water in the basin, mostly for the city of Billings. Most rural residents rely exclusively on ground water for domestic supplies. Other offstream uses, such as industrial and cooling water for thermoelectric power generation, consume relatively less water.

Instream flows support electrical generation at Yellowtail Dam and Mystic Lake, plus fisheries and recreation. World famous trout fisheries like the Shields, Boulder, and Stillwater rivers are known for their annual caddisfly and salmon fly hatches. Small tributaries upstream of Livingston in the Paradise Valley annually attract visitors from around the world. The Beartooth Plateau, an alpine expanse northeast of Yellowstone Park, features 400 alpine lakes filled with species such as cutthroat, rainbow, and brook trout. Downstream of Billings, warm water species like sauger and walleye thrive. The Bighorn River, with cold water discharges from Yellowtail Dam, harbors a renowned rainbow and brown trout fishery.

Water Quality

Water quality varies within the Yellowstone River basin. Many of its upper basin tributaries are prized for their pristine quality, but some have been degraded by metals and acid mine drainage. Arsenic levels are elevated from geologic materials in some of the upper basin waters and in the Powder and Tongue River drainages. In the middle and lower basin, land-use practices impair water quality through habitat alterations, high salinity, and addition of sediment, nutrients, and chemicals. Near Billings, bacterial contamination indicates potential pollution from industrial and municipal discharge.

Ground water in the Yellowstone basin is threatened by a variety of contaminants. Surface spills of pollutants and over-application of chemicals can impair shallow ground water deposits near rivers. Major industries can also contribute to water impairment of these aquifers. Septic systems throughout the basin can pollute shallow wells with nitrates and viral contaminants.

Water quality generally is good in deeper bedrock aquifers near the mountains. Quality decreases, though, in bedrock aquifers in the plains to the north and east because these aquifers are recharged more slowly. As water travels through bedrock for a great distance or a long time, increasing amounts of iron, fluoride, nitrates, trace metals, and salts leach into the water. These aquifers are also vulnerable from old oil drilling practices where oil and water migrate into the ground water through abandoned bore holes.

Issues and Concerns in the Yellowstone Basin

- **Proposed mining operations** in the headwaters of major tributaries to the Yellowstone River have raised concerns. A gold mine is proposed near Cooke City and Yellowstone National park in the headwaters of the Stillwater and Clark's Fork rivers and of Soda Butte Creek, which flows into another tributary of the Yellowstone. The Stillwater and Boulder rivers drain an area of the Beartooth/Absaroka Wilderness that contains the largest deposit of platinum and palladium in North America.
- **Water supply** is often insufficient to satisfy demands in the Powder River region.
- **The largest coal producing region** in the United States spans the basins of the Powder and Tongue rivers. Water quality in this region has shown degradation.
- **Increasing salinity** in the Powder River basin can harm soil productivity. Changes in Wyoming water management associated with coal and natural gas extraction and expansion of irrigation to more marginal soils in Montana contribute to the problem.
- **Water supply** for both instream and offstream uses may decline downstream when the Tongue River Dam is raised and rehabilitated to satisfy the Northern Cheyenne Reserved Water Rights Compact, a water rights agreement between the tribe and the State of Montana.
- **Reserved water rights** are being quantified for two Indian reservations, Bighorn Canyon National Recreation Area, Little Big Horn Battlefield National Monument, and the Forest Service. A compact has been established with the Northern Cheyenne, and negotiations are pending with the Crow. Until these rights are settled, future water availability will be uncertain.
- Most **water reservations** for consumptive uses that were granted by the Board of Natural Resources and Conservation in 1978 have yet to be developed. Their potential impact on other future water uses is not fully known.
- Yellowstone cutthroat now inhabit less than 8% of their estimated historic range. **Reduced stream flows, habitat changes and competition and hybridization from other species** are contributing factors in the population decline. Several ongoing and proposed water leases are helping to restore the species.

Water Use in the Yellowstone River Basin, 1980

	Withdrawn (1,000 acre-ft/year)	*Consumed (1,000 acre-feet year)*
Hydroelectric Power Generation	2,380	0
Thermoelectric Power Generation	94	9
Self-supplied Industry	11	1
Municipal	38	15
Rural Domestic	3	3
Irrigation	4,468	943
Livestock	9	9
Basin Total	***7,003***	***980***

These figures assume all water passing through turbines is returned to the river downstream, they don't reflect the fact that evaporation from reservoirs contributes greatly to consumptive losses

• **Geothermal features** within Yellowstone National Park could be impacted by water development in the region. A compact between the State of Montana and the National Park Service now identifies geothermal areas in Montana near the park as controlled ground water areas that require special permits for water use. Federal legislation also has been proposed to control water development in this sensitive area.

• **Nonpoint pollution** in the lower Yellowstone continues to contribute significant loads of sediment to the river.

Columbia River Basin

Montana's portion of the Columbia River basin is drained by the Clark Fork of the Columbia and Kootenai River systems. Their combined watersheds drain all the land in Montana west of the Continental Divide, about one-fifth of the state.

Clark Fork Basin

The Clark Fork of the Columbia, known locally as the Clark Fork River, originates near Butte. (Note that this river is different from the Clark's Fork of the Yellowstone, which drains into the Yellowstone River basin.) As it flows through northwestern Montana, it drains about 22,000 square miles. Although it is smaller than either the Yellowstone or Missouri River basins, it discharges substantially more water—almost 16 million acre-feet annually at the state line. Major tributaries include the Bitterroot, Blackfoot, and Flathead rivers.

The Flathead River watershed drains the northern part of the Clark Fork basin. Its headwaters arise in Glacier National Park, the Bob Marshall Wilderness, and Canada. Most of the drainage is rugged and forested. The terrain opens up along the glacially-formed trough that confines Flathead Lake, the largest fresh water lake in the United States west of the Mississippi. Elevations range from over 10,400 feet in Glacier National Park to 2,893 feet at Flathead Lake.

The Upper Clark Fork basin, which extends from Butte to Missoula, contains heavily forested mountains and broad valleys. Elevations range from about 10,700 feet in the Pintlar Wilderness near Anaconda to about 3,000 feet near Missoula. This part of the basin includes the driest area, the rainshadow east of Anaconda where less than ten inches of precipitation falls each year.

Flathead River float trip. Photo courtesy Travel Montana Department of Commerce

The Lower Clark Fork basin is also mountainous and forested, and contains the long, broad Bitterroot Valley. Elevations range from over 10,000 feet in the Bitterroot Mountains to 2,175 feet at Cabinet Gorge Reservoir, where the Clark Fork leaves Montana. In the mountains of this far western part of the state, 100 inches of precipitation may fall each year.

More than twenty large reservoirs, including natural lakes, collect water in the Clark Fork River basin. Each has greater than 5,000

acre-feet storage capacity. The largest natural water body is Flathead Lake whose capacity was increased by the construction of Kerr Dam at its southern tip.

One-third of Montana's population lives in the Clark Fork basin, concentrated in three of the state's largest population centers—Missoula, Butte, and Kalispell. Timber harvesting, tourism, and agriculture are the major industries, but the economy also relies on mining and metal processing, light industry, and government and university activities.

Water Use

As in the Yellowstone and Missouri River basins, irrigation is the major offstream use of water in the Clark Fork basin. Surface water irrigates fields of alfalfa, hay, and wheat, plus produce such as cherries, mint, and seed potatoes. Irrigation uses about 95 percent of the total amount of offstream water used in the basin—public drinking water supplies use less than three percent. This public water supply draws from both surface and ground water, depending on the location. For example, Missoula and Kalispell receive their water supply from aquifers. Most rural residents also rely on the ground water for their domestic needs. If they live in the Upper Flathead Valley, their water comes from a sand and gravel aquifer about 30 feet deep and up to 5 miles wide. In other parts of the basin, water may come from alluvial aquifers, 200-400 feet below the surface, and from bedrock aquifers in the hilly or mountainous areas.

Instream flows support electrical generation, fisheries, and recreation. About 25 percent of Montana's electric generating capacity comes from hydroelectric power generation in the Clark Fork basin. The region's six blue ribbon streams lure flyfishing enthusiasts from around the world. They also flock to the Flathead basin's unique bull trout and westslope cutthroat fishery. Boaters, floaters, and swimmers enjoy the rivers, lakes, and reservoirs of the Clark Fork basin.

Water Quality

Water quality ranges from blue ribbon trout streams to the nation's largest complex of Superfund sites along the Clark Fork. The upper Clark Fork, from Butte to Missoula, was a world-famous mining area from the late 1800s to the 1970s. Waste products from these mining and smelting operations resulted in heavy metals such as copper and zinc accumulating in the sediments. When the rivers are running high, they can disturb the sediments and release these toxic contaminants that can kill fish and other aquatic life. The contaminants are also migrating into the ground water. Wells in the Anaconda area were contaminated by smelting operations, and some domestic wells in the Milltown areas were closed when arsenic began appearing in the water.

Water Use in the Clark Fork River Basin, 1980

	Withdrawn (1,000 acre-ft/year)	*Consumed* (1,000 acre-feet/year)*
Hydroelectric Power Generation	27,611	0
Thermoelectric Power Generation	0	0
Self-supplied Industry	34	5
Municipal	46	17
Rural Domestic	5	5
Irrigation	1,852	521
Livestock	3	3
Basin Total	***29,550***	***551***

**These figures assume all water passing through turbines is returned to the river downstream; they don't reflect the fact that evaporation from reservoirs contributes greatly to consumptive losses.*

Near Missoula, municipal runoff and agricultural practices impair aquifer quality; in Kalispell, septic systems are contaminating ground water. Wood-pulp plants, municipal wastewater treatment plants, and the addition of nitrates and phosphates from high-impact residential development in areas like the Bitterroot and Flathead valleys also impair ground and surface water quality in the region.

Issues and Concerns in the Clark Fork Basin

- The Flathead Basin Commission is monitoring activities that contribute to the following problems.
  - —**Nutrient overload**, which initiates eutrophication (aquatic plant overgrowth), is occurring in Flathead Lake as a result of the most rapid population growth in Montana.
  - —**Releases of water from Hungry Horse Dam** are of concern because of tradeoffs between power generation and downstream anadramous fishery demands.
  - —**Changes in plant and fish distribution** are occurring, especially migratory fish species, in Flathead Lake and Flathead River.
- **Multiple jurisdictions** complicate management of the Flathead basin. The jurisdictions which share overlapping management responsibilities include the Salish and Kootenai Indian Reservation, the Northwest Power Planning Council, Glacier National Park, the Flathead National Forest, and British Columbia.
- **Hydropower production and providing for salmon** are two issues pending between Canada and the United States as they negotiate the Columbia River Treaty and the long-term management of Hungry Horse Reservoir.
- **Reserved water rights claims** of the Salish and Kootenai Confederated Tribes create uncertainty regarding water available for future water users.
- **Water quality degradation** on the Blackfoot River has led to the U.S. Environmental Protection Agency identifying it as a river with nationally significant problems. The problems have accumulated from long-term logging, mining, and agricultural practices. The Blackfoot Challenge, a consortium of landowners, farmers and ranchers, interest groups, and agencies is developing a strategy to protect the natural resources and rural lifestyle of the Blackfoot River valley.
- **Rapid development** in the Bitterroot drainage is increasing nonpoint source pollution and the withdrawal of water by suburban users. A group of local citizens has formed the Bitterroot Water Forum to address these issues.
- **Water quality degradation** along the Upper Clark Fork from old mining operations is also affecting water quality in the Lower Clark Fork. These Superfund sites are under intense study.
- **Inadequate water supply** in the Flint Creek drainage has led citizens and agencies to prepare a return flow study that will allow water users to better gauge water use scheduling.
- **Years of *dewatering*** in the upper Clark Fork basin led to proposals for water reservations for both instream and offstream uses, which then generated conflict. To handle these complicated issues, the Montana legislature set up the Upper Clark Fork Basin Steering Committee to develop a water management plan balancing all water uses upstream of Milltown Dam. Subsequent legislation imposed a moratorium on the issuance of water rights for new uses, closed the basin to most additional water appropriations, and authorized development of a ten-year Upper Clark Fork instream flow pilot program.

• To address **nutrient build-up** and ***eutrophication*** in Idaho's Lake Pend Oreille and in the entire Clark Fork-Pend Oreille basin, the states of Idaho, Montana, and Washington, and many agencies and interests have developed a watershed plan that includes phosphate detergent bans, installation of centralized sewage systems for developed areas on Lake Pend Oreille, and nutrient loading targets for Clark Fork River.

Kootenai River Basin

Located in the northwest corner of Montana, the Kootenai River basin carries huge amounts of water on its brief 95-mile journey through the state. Its headwaters originate in British Columbia, and the river loops through Montana and Idaho and back into Canada before discharging into the Columbia River just north of the Washington State border. The basin drains less than three percent of Montana, but it discharges more than the Yellowstone or Missouri rivers. Three-fourths of this water originates in Canada. Warm, wet air masses from the Pacific contribute to this volume of water, bringing abundant rain and from 40 to 300 inches of snowfall each year.

Montana's portion of the Kootenai basin is narrow, with steep, densely-wooded mountains and slender flood plains along the river and its two major tributaries—the Fisher and Yaak rivers. The upstream portion of the Kootenai River is dominated by Libby Dam and its reservoir, Lake Koocanusa, which impounds 48 miles of the river in Montana and extends an additional 43 miles into Canada. The reservoir's storage capacity is exceeded only by Fort Peck in the Missouri basin. Downstream of Libby Dam is Kootenai Falls, a 700-foot wide, 30-feet high natural falls that was once considered for hydroelectric development. Elevations range from 7,500 feet in the mountains to about 1,800 feet where the river exits the state.

The Kootenai basin is sparsely populated. It encompasses only one county, Lincoln. Its county seat, Libby, has a population of 2,532; the entire basin population is 17,500. Forest products, mining, and recreation provide the main economic activity in this region.

Water Use

Although little agriculture occurs here compared to other parts of Montana, irrigation still utilizes the most water in the Kootenai River basin. Most irrigation water is drawn from surface supplies. Mining and the wood products industry also use significant amounts of water. Public and rural water supplies—drawn almost equally from surface and ground water—account for about three percent of the water used.

As in the other major river basins, instream flows in the Kootenai River basin support electrical power generation, fisheries, and recreation. Hydroelectric generation at Libby Dam, which provides one-tenth of Montana's electrical generating capacity, uses the most instream water. Rainbow trout, mountain whitefish, and Montana's only population of white sturgeon also depend on instream flows of the Kootenai and its tributaries. Their presence attracts people to this region for fishing and boating.

Water Quality

Water quality in the Kootenai River basin depends on what kind of human activities have occurred nearby. Forest practices, agriculture, and mining have all contributed contaminants to local waters. Septic systems impair some ground and surface waters. Creosote compounds and pentachlorophenol from an abandoned disposal pit at a lumber mill have contaminated the aquifers beneath Libby. Overall, though, most alluvial aquifers in the basin contain good quality water and the basin's waters contain lower concentrations of dissolved chemicals than elsewhere in Montana.

Water Use in the Kootenai River Basin, 1980	Withdrawn (1,000 acre-ft/year)	Consumed* (1,000 acre-feet/year)
Hydroelectric Power Generation	6,729	0
Thermoelectric Power Generation	13	0
Self-supplied Industry	15	2
Municipal	2	1
Rural Domestic	1	1
Irrigation	38	13
Livestock	**	**
Basin Total	***6,798***	***17***

*These figures assume all water passing through turbines is returned to the river downstream; they don't reflect the fact that evaporation from reservoirs contributes greatly to consumptive losses.

** Insignificant

Issues and Concerns in the Kootenai Basin

The Kootenai River Network, an interstate and international alliance of agencies and interest groups, formed in 1991 to develop a watershed protection strategy for the Kootenai basin. The issues listed below inspired this effort.

- **Water releases** from Libby Dam concern recreationists and proponents of increased power development. Boaters wish the reservoir to remain at full pool for easier access. (See diagram on page 22.) People who fish want to ensure sufficient water downstream to maintain the water velocity and depth that sturgeon requires for spawning.
- **Anadromous kokanee salmon** are threatened in British Columbia due to changes in river and reservoir levels caused by operations at Libby Dam and decreases in nutrient availability in Kootenai Lake.
- **Planned mining practices** on Libby Creek concern people because of the potential impacts on water quality should tailings ponds leak.
- **Hydropower production** and providing for *salmon and sturgeon* are two issues pending between Canada and the United States as they renegotiate portions of the Columbia River Treaty which could affect the long-term management of Libby Reservoir.
- **Widespread logging** and associated road building, which occurs throughout the basin at all elevations, can impact trout populations by increasing the amount of sediment in surface waters.
- **Ground water contamination** in the town of Libby forced residents to cap their private wells and use an alternative water supply. The contaminated soils are being excavated in an effort to mitigate the pollution.

For More Information

- *How the River Runs: A Study of the Potential Changes in the Yellowstone River Basin*. 1981. Montana Department of Natural Resources and Conservation.
- "The Yellowstone River." 1985. *Montana: The Magazine of Western History*. Autumn 1985. Montana Historical Society.
- *The Missouri River Report*. A quarterly publication of the Missouri River Basin Association. Box 9193, Missoula 59807.
- *Flathead Basin Commission 1993-1994 Annual Report*
- *Upper Clark Fork River Basin Water Management Plan*. 1994. Upper Clark Fork River Basin Steering Committee.

Managing Montana's Water

Every person who lives in or visits Montana participates in water management because we drink the water and wash with it, play in it, and conserve and protect it. Water management involves people who allocate water supplies, issue permits, regulate the resource according to state and federal laws, and enforce laws when violations occur. Without water management, more human wastes would end up in rivers, drinking water would be contaminated, crops would wither during drought, and water might not always be available.

Because every layer of government plays some part in water management, effective water management requires communication and collaboration among diverse individuals, interest groups, and government officials.

The Federal Role

Federal authority for water management is implied in the U.S. Constitution, although water is never mentioned by name. In each state, the federal role comes from several specified powers:

- **Commerce power**—The U.S. Congress has jurisdiction over all navigable waters of the United States. The commerce power includes flood protection and watershed development.
- **Proprietary power**—The property clause of the Constitution gives Congress unlimited authority to control the use of federal public lands. The property clause allows construction of federal reclamation projects and regulates electrical power generated at federal dams.
- **Treaty-making power**—Only the federal government has authority to enter into treaties with foreign nations and American Indians. The treaty-making power is one basis for the *reserved water rights* of Indian tribes in Montana.
- **General welfare power**—The federal government has authority to provide for the general welfare of the United States and its citizens "for the common benefit," rather than for only "local purposes."
- **Equitable apportionment**—When controversies arise among states over water, the U.S. Supreme Court has the power to decide the controversy.
- **Interstate compacts**—These *negotiated agreements* or *compacts appropriate* waters that cross state boundaries. The compacts must be ratified by Congress.

In Montana, the federal government is involved with water management in multipurpose projects such as Hungry Horse Dam (Bureau of Reclamation) or Fort Peck Reservoir (Army Corps of Engineers), irrigation projects like the Yellowstone and Milk River Irrigation Districts (Bureau of Reclamation), wildlife refuges such as the Charles Russell National Wildlife Refuge (U.S. Fish and Wildlife Service), and water and wastewater treatment facilities managed by municipal governments (regulated by the Environmental Protection Agency).

Water Policy Evolution

Federal water policy generated a network of inland waterways, dams, reservoirs, water treatment systems, scenic rivers, fish hatcheries, municipal supply systems, irrigated lands, and hydroelectric operations. This development had a five-phase evolution:

1. Early regulation of harbors, waterways, and fisheries, with an emphasis on settlement and development (navigation, flood control, and irrigation),
2. Promotion of a conservation ethic, for benefit of future generations (1900 to 1920s),
3. Major large-scale construction of multipurpose reservoirs (1930s to 1950s),
4. Nationwide river basin planning (1950s and 1960s), and
5. Environmental protection and education (1970s to 1990s).

What Is Equitable Apportionment?

States are obligated to share interstate waters. If the actions of one state harm or reduce another state's share of interstate waters, the affected state may ask the Supreme Court to apportion, or distribute, the water resource.

What Are Federal Reserved Water Rights?

In January 1908, the United States Supreme Court defined federal reserved water rights in the *Winters v. United States* decision involving members of the Fort Belknap Reservation in Northern Montana and non-Indian irrigators in the Milk River drainage. The court decided that when federal lands were withheld from settlement and reserved for some purpose, water rights were also reserved.

Federal lands with reserved water rights in Montana include seven Native American reservations, land managed by the Forest Service, national parks and monuments managed by the National Park Service, wild and scenic rivers and other lands managed by the Bureau of Land Management.

Three issues dominate quantification of federal reserved water rights: uses for which the right can be exercised, the quantity of the right, and the priority of the right. In Montana, these issues are negotiated and stated in a compact that is then ratified by the holder of the federal water right, the Montana legislature, and the U.S. Congress. A reserved water right exists whether or not it is actually in use.

Milestones in Federal Water Policy

The federal role in water management in Montana has evolved over time. That evolution is expressed in the laws created and amended by Congress, in decisions of the federal courts, and through agency regulations that convert laws into meaningful practices in the real world.

1862 *The **Homestead Act** was passed, providing free 160-acre farms to all American citizens whose settlement efforts endured a five-year trial period.*

1868 ***First homestead application** was filed in Montana.*

1872 *For the purpose of encouraging settlement and economic development in the west, the **Mining Law** set up a system for patenting, at a minimum price, public land for minerals extraction.*

1877 ***Desert Land Act** provided for the settlement of Western lands and for the use of water by prior appropriation, reserving the unused water for future appropriations.*

1899 *The **Rivers and Harbors Act** authorized the U. S. Army Corps of Engineers to control construction in navigable waters and adjacent wetlands. Initially enacted to protect navigation, the act is now interpreted to prohibit discharge of refuse materials into navigable waters.*

1902 *To promote irrigation, the **Reclamation Act** created the Bureau of Reclamation and authorized it to construct irrigation projects—reservoirs, dams, and canals—in the western United States and territories. Landowners of tracts under 160 acres were eligible for water use and required to repay project costs over time. This prompted early development of smaller farms. One of the first Reclamation projects diverted water from the St. Mary's River to the Milk River basin.*

1909 *The **Boundary Waters Treaty** established a long-standing cornerstone for United States-Canadian bilateral cooperation, setting out principles to settle border disputes, including those involving water allocation.*

1920 *The **Federal Water Power Act** established a national hydropower policy and created the Federal Power Commission (now the Federal Energy Regulatory Commission) to license private hydropower facilities, regulate interstate transmission of electricity, and set up a comprehensive plan for all water power development that carefully considers competing uses.*

1936 *The **Flood Control Act** authorized the construction of 200 dams for flood control and introduced cost-benefit analyses to verify that the benefits of federal water projects exceed their costs.*

1944 *This **Flood Control Act** authorized construction of six large-scale reservoirs on the Missouri for flood control, hydroelectric development, navigation, and irrigation water development in the 10-state Missouri basin. The act also authorized the Pick-Sloan Missouri Program, which established two plans. The Pick Plan, operated by the Army Corps of Engineers, advocates flood control and navigation for downstream states in the Missouri basin. The Sloan Plan, operated by the Bureau of Reclamation, develops water for consumptive uses, especially in upstream states like Montana. Conflicts stemming from these two plans persist today.*

1945 *The **Missouri Basin Interagency Committee** produced the Missouri Basin Comprehensive Framework Study in 1969, which provided baseline data for the entire basin.*

1948 *The **Federal Water Pollution Control Act** required states to locate water polluters and reduce or eliminate harmful discharges and provided federal financial assistance to construct municipal wastewater treatment facilities. This act and its amendments (1972, 1977, 1987) are often referred to collectively as **The Clean Water Act.***

1956 *Amendments to the **Federal Water Pollution Control Act** increased federal financial assistance to construct municipal wastewater treatment facilities.*

1958 *The **Fish and Wildlife Coordination Act** gave the U.S. Fish and Wildlife Service and appropriate state agencies the right to review all project proposals to ensure that impacts to fish and wildlife are adequately considered during the planning phase of water development projects.*

1965 *The **Water Resources Planning Act** established the Water Resources Council to oversee water resources planning and development at the federal level.*

1965 *The **Water Quality Act** revised prior water quality legislation, requiring all states to classify interstate waters by 1967. The law set up the Federal Water Pollution Control Administration in the Department of the Interior to enforce water quality standards.*

1968 *In an effort to preserve outstanding scenic rivers in the nation, the **Wild and Scenic Rivers Act** was passed. Administered by the National Park Service of the Department of the Interior, states may recommend protection by Congress of certain "wild and scenic" river reaches; these must be approved by the Secretary of the Interior.*

1969 *The **National Environmental Policy Act (NEPA)** requires the preparation of an environmental impact statement (EIS) for any project requiring federal action such as permitting or construction. The act does not require the federal government to choose the most environmentally-sound alternative outlined in the EIS; it does require an explanation of why an alternative was authorized. The act also set up the Council on Environmental Quality to develop national environmental policies.*

1972 *The **Federal Clean Water Act Amendments** to the 1948 law gave states the authority to administer portions of the federal water quality program, introduced effluent limitations for industrial discharges, and set up a national permit system for point source discharges.*

1974 *The **Federal Safe Drinking Water Act** bolstered earlier legislation to assure safe public drinking water supplies. It authorized the Environmental Protection Agency to set up national primary drinking water standards (Maximum Contaminant Levels) and regulations for underground injection wells.*

1976 *The **Federal Resource Conservation and Recovery Act** delegated authority to the Environmental Protection Agency and qualified states to develop solid waste disposal programs for sludge and hazardous materials.*

1976 *The **Toxic Substances Control Act** gives the Environmental Protection Agency authority to regulate the manufacture and disposal of chemical substances.*

1977 *The **Clean Water Act** amended the Federal Water Pollution Control Act by establishing ambitious goals:*

- *the elimination of pollution discharges into navigable waters by 1985*
- *water quality suitable to protect fish and recreation by 1983*
- *no discharge of toxic pollutants*
- *construction of waste treatment works*

Three sections have been particularly significant:

- *Section 404 set up a program, administered by the U.S. Army Corps of Engineers, that requires permits for dredging or filling wetlands.*
- *Section 401 created a National Pollution Discharge Elimination system (NPDES), administered by the Environmental Protection Agency and qualifying states, that prohibits the discharge of pollutants from a point source unless NPDES grants a permit.*
- *Section 311 prohibits the discharge of hazardous substances in harmful quantities.*

1980 ***Federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)** gives authorization to states to develop plans for cleanup of and protection from hazardous waste spills and disposal sites. It also established a trust fund known as the "Superfund" that supports cleanup of sites on the National Priorities List.*

1985 *The **Food Security Act** discouraged the filling or draining of wetlands by denying federal farm benefits to farmers harvesting an annual crop on converted wetlands.*

1986 *Title IX of the **Water Resources Development Act** funded the implementation of state dam safety programs.*

1986 *The **Safe Drinking Water Act** was amended to authorize states to establish statewide wellhead and aquifer protection programs. It also authorized the Environmental Protection Agency to establish national drinking water standards for 83 contaminants.*

1987 *The **Water Quality Act** reauthorized the Clean Water Act, with a specific goal for states to control nonpoint sources of pollution. It requires the Environmental Protection Agency to develop regulations for stormwater runoff control, and phased out federal grants for municipal wastewater treatment facilities.*

The State Role

The framers of Montana's 1972 Constitution made it clear that a close relationship exists between the state's natural resources and a high quality of life. The natural environment was deemed so important by those who revised the Constitution that they devoted an entire section to it—Article IX, "Environment and Natural Resources"—and designated the state government as custodian of Montana's excellent water quality.

Section One of Article IX also assigned shared responsibility for protection and improvement of Montana's water: "The state *and each person* shall maintain and improve a clean and healthful environment in Montana *for present and future generations.*" The Montana legislature bears responsibility for "the administration and enforcement of this duty"—including protection of "environmental life support systems" and for preventing "unreasonable depletion and degradation of natural resources." In addition, the Constitution established the governmental framework for water use, appropriation, channelization, damming, conveyance, regulation, protection, treatment, and monitoring.

Water rights, which regulate water quantity, are singled out in Section Three: "All existing rights to the use of any waters for any useful or beneficial purpose are hereby recognized and confirmed." It further clarifies that all uses of water, regardless the nature, are considered public uses. And it declares *all* waters within state boundaries (ground water, surface water, flood waters, and atmospheric waters) are the property of the state "for the use of its people."

Mining interests in the West championed the first water rights based on the prior appropriation doctrine—first in time to use water is first in right. This rule still guides water use in most western states, especially during times of water shortage. Now, however, municipalities, recreationists, irrigators and ranchers, industries, miners, fish and wildlife, and hydroelectric generation all tug on the water supply. To avoid over-appropriation and pollution in watersheds, state legislation guides the use and protection of Montana's rivers, lakes, and ground water. Generally, water management in Montana is determined by the intended use of water, existing flood or drought conditions, demand for water, government jurisdiction, and water quality constraints.

Irrigation Wheel. Photo courtesy Montana Historical Society, Helena, Montana

Preamble of the Montana State Constitution

We the people of Montana, grateful to God for the quiet beauty of our state, the grandeur of our mountains, the vastness of our rolling plains, and desiring to improve the quality of life, equality of opportunity and to secure the blessings of liberty for this and future generations do ordain and establish this constitution

The Water Adjudication Process

The Montana Water Court, headquartered in Bozeman, *adjudicates* (settles) water rights in the state. It began this process in 1979 to clear up confusing rights or settle conflicting claims in all of Montana's 85 river basins. By April 30, 1989, over 201,000 claims were filed for water rights. As of 1995, the court had issued some type of decree (court-defined settlement) of rights in 49 of the basins and for two Indian water right compacts. Approximately 23,000 claims are pending. The Water Court resolves these objections through pretrial conferences and hearings, and concludes with Master's Reports that must be reviewed and adopted by one of the five Montana water judges

The State Water Plan

The State Water Plan is required by state law to "... set out a progressive program for the conservation, development, and utilization of the state's water resources" The plan addresses watershed planning, instream flow protection, and agricultural water use efficiency. It also provides a forum for people to approach water management issues and concerns in a consensus building process

Milestones in State Water Policy

1842 *Jesuit Fathers irrigate lands using water from Burnt Fork Creek in the Bitterroot*

1852 *Earliest water use right established for Burnt Fork Creek irrigation.*

1864 ***Territory of Montana established** by an act of Congress in 1889.*

1868 ***First homestead application** filed in Montana.*

1899 *Article III, Section 15 of the **Montana Constitution** states that use of all waters shall be held a public use.*

1907 ***State Board of Health** receives authority to control pollution where it affects domestic water supply.*

1934 *The **State Water Resources Survey** begins a county-by-county inventory of Montana's water resources; State Water Conservation Board created to construct water diversion and storage projects.*

1950 ***Yellowstone River Compact** approved by Congress.*

1955 *The **Montana Water Pollution Control Act**, Montana's first water quality act, protects water uses other than domestic supply. It set up the Water Pollution Control Council and authorized stream classifications and enforcement procedures.*

1960 *The **Montana Stream Protection Act** requires the Montana Department of Fish, Wildlife and Parks to administer a stream protection permit program for projects that may affect the natural existing shape of any stream, its banks, or tributaries.*

1961 ***Montana Board of Water Well Contractors** is formed to establish standards for drilling and licensing of water wells.*

1967 ***Montana Water Resources Act** was the first legislation aimed at developing a comprehensive water plan for Montana.*

1967 ***Montana Water Quality Act** became Montana's unified water quality legislation, and created state agency responsibilities for water quality regulation*

1971 *The **Montana Environmental Policy Act** (MEPA) directs all state agencies to prepare environmental impact statements for any actions that might affect the environment. The act also created the Environmental Quality Council, a legislative office, to promote the goals of MEPA.*

1971 ***Montana Water Pollution Control Law** was rewritten. It made the Water Pollution Control Council advisory and gave authority to Board of Health.*

1971 ***Metal Mine Reclamation Act (also called the Hard Rock Mining Act)** requires that anyone engaged in production and exploration of mining properties obtain licenses and permits.*

1971 ***Montana Strip and Underground Mine Siting Act** gives the Montana Department of State Lands authority to review proposed coal and uranium mine sites and reclamation plans to determine whether the proposals are acceptable*

1971 ***Montana Opencut Mining Act** addresses reclamation and conservation of land subject to open cut mining (for gravel, clay, bentonite etc.). It is administered by the Department of State Lands.*

1972 *The **Montana Constitution**, revised and approved by voters, recognizes all existing water rights, provides for use of all waters subject to appropriation under law, and provides for administration of water rights records. In general, the revised Constitution recognized a need to protect and restore the environment.*

1973 ***Montana Water Use Act** set up a permit system for all post 1973 water rights, an adjudication process for quantifying all pre-1973 water rights, and a system to set aside or reserve water for future consumptive and instream flow use*

1973 *The **Flood Plain and Floodway Management Act** restricts uses that are dangerous to public health and the safety of property in times of flood. Flood plain maps, prepared by the Natural Resource Conservation Service (formerly Soil Conservation Service), Montana Department of Natural Resources and Conservation, and others, are the technical basis for developing local floodplain regulations*

1973 ***Montana Water Quality Act**, and subsequent amendments and regulations, authorizes the Montana Department of Environmental Quality to classify surface waters and establish surface water quality standards and a permit program to control the discharge of pollutants into state waters.*

1973 ***Montana Major Facility Siting Act** and subsequent amendments authorize the Facility Siting Bureau of the Montana Department of Natural Resources and Conservation to determine the need for major facilities (including hydroelectric plants), and to assess whether the site chosen will minimize environmental affects.*

1975 ***Natural Streambed and Land Preservation Act** requires a permit (commonly known as the 310 permit) from the county Conservation District for activities affecting the bed and banks of a perennial stream.*

1975 *The **Lakeshore Development Act** conserves and protects Montana's natural lakes, and provides local governing bodies with adequate statutory power to protect lake areas. Since this act passed, five local governing bodies have developed lakeshore regulations.*

1977 ***Montana Solid Waste Management Act** and 1991 amendments grant the Department of Environmental Quality the authority to develop rules for development and inspection of solid waste management systems for hazardous wastes, decomposable wastes, and non-water soluble wastes.*

1979 *Best known as **Senate Bill 76**, this law set up a Reserved Water Rights Compact Commission to negotiate federal and Native American water rights, and created the Montana Water Court to accelerate the adjudication of claimed water rights*

1981 ***Montana Hazardous Waste and Underground Storage Tank Act** provides for state permitting and siting of hazardous waste facilities.*

1985 ***Montana Hazardous Waste Act** was amended to authorize the Department of Health and Environmental Sciences to implement an underground storage tank regulatory program.*

1989 ***Montana Comprehensive Environmental Cleanup and Responsibility Act** set up a water quality fund to protect Montana citizens from hazardous wastes by providing a state "Superfund" for cleanup of sites where no voluntary steps have been taken*

1989 ***Montana Agricultural Chemical Ground Water Protection Act** requires preparation of agriculture chemical ground water management plans for areas where an agricultural chemical is detected in ground water at 50 percent of the ground water quality standard for that chemical*

1991 ***Montana Megalandfill Siting Act** ensures that the location, construction, and operation of large landfills will produce little impact to the environment*

1991 ***Montana Ground Water Assessment Act** established a committee to oversee ground water monitoring and assessment activities, coordinated permitting fees, and set up a fund for coordinated ground water characterization and monitoring.*

1991 ***Streamside Management Zone Law** protects the quality and quantity of forest waters by requiring permits for certain forest practices within 50 feet of any stream or lake.*

Agency Responsibilities—Who Does What?

Federal Agencies

Department of Agriculture

Consolidated Farm Service Agency administers [illegible] program for farmers that [illegible] water quality [illegible] and irrigation systems.

Natural Resource Conservation Service assists private landowners with watershed protection, flood prevention, soil and water conservation [illegible] and [illegible] plant studies and [illegible] assessments.

Forest Service conducts watershed management [illegible] national forests in Montana and manages [illegible] wild and scenic river reaches within the forest boundaries.

Department of the Army

Corps of Engineers [illegible] permits for private projects [illegible] waters [illegible] navigation, flood control, hydroelectric generation [illegible] flood damage reduction.

Department of Commerce

Economic Development Administration provides public works grants for community [illegible] development.

National Oceanic and Atmospheric Administration issues information on weather [illegible] and climatic conditions; maintains a flood warning system.

National Weather Service forecasts weather and issues weather warnings and watches.

Department of Energy

Bonneville Power Administration markets electric power for the 30 hydroelectric projects of the federal Columbia River Power System; operates transmission systems.

Western Area Power Administration distributes and markets power from federal [illegible] the Columbia River basin; operates transmission lines.

Department of Housing and Urban Development

Provides [illegible] and for [illegible] water resource projects.

Department of the Interior

Bureau of Indian Affairs [illegible]

Bureau of Land Management [illegible]

Bureau of Reclamation [illegible] water [illegible] conservation efforts.

Fish and Wildlife Service [illegible] fish and wildlife habitat [illegible] species; manages hatcheries; studies fish disease.

National Park Service [illegible]

U.S. Geological Survey [illegible] availability of surface and ground water [illegible] reports.

Department of Transportation

Federal Insurance Administration operates the National Flood Insurance Program, which insures buildings on flood plains at reasonable cost.

Federal Emergency Management Agency publishes maps showing flood prone areas; provides assistance during emergencies caused by natural events.

Environmental Protection Agency

Works with states to establish and enforce standards for water quality and drinking water standards; provides grants for water pollution control [illegible]

Federal Energy Regulatory Commission

Issues licenses for hydroelectric projects and transmission lines.

State Agencies

Department of Agriculture

Registers pesticide products; monitors well design and sampling for pesticide detection.

Department of Fish, Wildlife, and Parks

Administers programs to protect and restore fish habitat in streams, lakes, and water quality for support of fishing opportunities; works to protect and improve wildlife habitat; maintains state parks and recreation sites; provides educational programs to adults and young people, including Aquatic Project WILD.

Department of Environmental Quality

Administers [illegible] pollution control programs that protect public health; issues permits [illegible] and agricultural discharges; monitors chemical and biological [illegible] of streams and lakes; administers funds for municipal wastewater treatment [illegible] nonpoint source water pollution control program [illegible] protection program [illegible] sanitary and environmental aspects of proposed [illegible]

Department of Natural Resources and Conservation

[illegible] Montana Water Court [illegible] water plan [illegible] Montana [illegible] interstate and international [illegible] Renewable Resource Development Program.

Reserved Water Rights Compact Commission

[illegible] federal agencies and Indian tribes that claim federal reserved water rights within Montana.

Montana Bureau of Mines and Geology

[illegible] at the Montana College of Mineral Science and Technology [illegible] gathers and publishes information [illegible] Ground Water Information Center [illegible]

Historic Preservation Office

[illegible]

Montana Environmental Quality Council

Oversees state environmental programs for the Montana Legislature [illegible] trends and advises the legislature on the adequacy of the state's water policy.

The Extension Service

Headquartered at Montana State University [illegible] offices, this service provides assistance and training [illegible] develops public information materials.

Montana State Library Natural Resources Information System

Montana's repository for natural resource data [illegible] agencies and organizations [illegible] the Montana Natural Heritage Program, the Montana Natural Resource [illegible] and the Montana Water Information System.

Montana Water Court

[illegible]

Montana University System

Provides [illegible] Montana State University (MSU) at Bozeman, Billings, and Northern (Havre), the University of Montana (UM) at Missoula, Montana College of Mineral Science and Technology (UM) at Butte, and Western Montana College (UM) at Dillon. [illegible]

- Agricultural Experiment Station
- [illegible]
- Center for Biofilm Engineering
- Flathead Lake Biological Station
- Montana Bureau of Mines and Geology
- Montana Cooperative Fishery Research Unit
- [illegible]
- Montana [illegible] Center
- Montana Watercourse and Project WET Montana
- MSU Chemistry Station [illegible]
- MSU Extension [illegible]
- Reclamation Research Unit
- The Watercourse and National Project WET
- University System Water Resources Center
- [illegible] Center for Mountain [illegible]

Continued →

Agency Responsibilities—Who Does What? (continued)

International and Multi-State Commissions

International Joint Commission
A six-member commission administers the Boundary Waters Treaty of 1909 and resolves water and other natural resource allocation issues shared by states and provinces along the 49th Parallel

Missouri River Basin Association
A forum for Missouri basin states, federal, tribal governments, and interest groups to come to consensus on water allocation issues

Yellowstone River Compact Commission
A water allocation compact among Montana North Dakota, and Wyoming.

Western States Water Council
A forum for western states to build mutual interests and support for the protection and wise management of water in the West.

Western Governors' Association
A regular meeting of 18 western state governors to discuss shared issues, including water resources topics. Its water program focuses on watersheds, Indian water rights, allocation, and collaboration

Flathead Basin Commission
A 22-member commission of state, federal, Canadian, tribal and private citizen members established by the 1983 legislature; charged with protecting Flathead Lake and the resources of Flathead basin while encouraging sound economic development

Missouri River Natural Resources Committee
A committee, comprised of representatives from seven Missouri basin state wildlife agencies, that makes recommendations to the U.S. Army Corps of Engineers about dam operations on the Missouri River

Northwest Power Planning Council
A council, with two appointed members from each of four northwestern states, that conducts regional power planning and fishery mitigation studies.

Tribal Agencies

Ordinances and codes regarding management of resources have been developed by agencies at some of Montana's seven tribal reservations: Chippewa and Cree Tribes (Rocky Boy Reservation), Confederated Salish and Kootenai Tribes (Flathead Reservation), Blackfeet Tribe (Blackfeet Reservation), Crow Tribe (Crow Reservation), Assiniboine and Sioux Tribes (Fort Peck Reservation), Fort Belknap Tribe (Fort Belknap Reservation), Northern Cheyenne Tribe (Northern Cheyenne Reservation).

Protecting Water for the Future

The 1973 Montana Water Use Act set up a *water reservation* process to provide for future beneficial uses and maintenance of minimum stream flows. Political subdivisions of the State of Montana, state agencies, and the United States or any of its agencies can apply to reserve water. The process is the first provision in Montana law that allows the creation of a water right for future use. It is also one of the only ways that an instream flow water right can be established for unappropriated waters.

For More Information

- *A Guide to Stream Permitting in Montana.* The Montana Association of Conservation Districts.
- *A Landowner's Guide to Western Water Rights.* 1994. The Watercourse, Montana State University–Bozeman.
- *Final Status of Natural Resource Legislation in the Legislature*. Biannual. Montana Environmental Quality Council.
- *Montana Environmental Law Handbook.* 1992. The Law Firm of Crowley, Haughey, Hanson, Toole, and Dietrich.
- *Montana Forestry BMPs.* Montana State University Extension Service.
- *Montana Index of Environmental Permits.* 1993. Environmental Quality Council.
- *Montana Placer Mining BMPs.* Montana Bureau of Mines and Geology.
- *Tips on Land & Water Management for Small Farms & Ranches in Montana.* Conservation Districts Bureau, Department of Natural Resources and Conservation.
- *Who Does What With Montana's Water? A Directory.* 1994. The Montana University System Water Center.

7 Involving Yourself in Local Management

The vital connection between larger watersheds and local activities in our homes, on our land, and in communities reveals itself through local involvement in water management. People in the profession of water management recognize that local individuals and communities can make the best managers of the state's waters. For this reason, state agencies are placing increasingly greater emphasis on local initiatives to protect, conserve, and manage Montana's water. In this chapter, you'll find descriptions of government and private groups that are managing the state's water resources. All of them encourage your participation—and welcome new initiatives.

Finding Other People

Montana Watercourse: "Know Your Watershed" Workshop

Your ability to participate in water management requires knowledge, scientific and technical information, and large doses of community dialogue. You can begin this learning process by participating in "Know Your Watershed" forums and field trips. The Montana Watercourse, in collaboration with local groups, develops water information seminars and field trips to give participants first-hand knowledge of local issues and diverse concerns.

Special Interest Groups

Farmers, wool growers, flyfishing enthusiasts, loggers, boaters, miners, businesses, ranchers, and developers all have a stake in how water is managed. Reflecting this diversity, a variety of special interest groups work on issues that affect Montana's water. Membership is open to you, and many groups have local chapters.

Coalitions for Local Watershed Planning

To deal with water supply and quality problems, people across Montana have created coalitions of local governments, state and federal agencies, businesses, and, most importantly, local citizens. They meet informally, consider shared problems and concerns, and work together to address them. One example is The Blackfoot Challenge, a forum that promotes cooperative resource management of the Blackfoot River, its tributaries, and adjacent lands. Like other coalitions in Montana, the Blackfoot Challenge attempts to avoid duplication of management and problem-solving efforts undertaken by varied public and private land owners.

Working with Local Government & Groups

You can participate in local water management by attending public hearings, commenting on plans, and advising agency officials about your concerns. Many proposed government plans or actions require public review and comment before they occur. Other groups such as local water user associations or canal companies also offer opportunities for citizen involvement.

Water-Related Interest Groups

- Audubon Society
- Alliance for a Clean Rural Environment
- Alternative Energy Resource Organization
- Beartooth Alliance
- Cabinet Resource Group
- Citizens for a Better Flathead
- Clark Fork Coalition
- Ducks Unlimited
- Flathead Irrigation Project
- Flathead Lakers
- Greater Yellowstone Coalition
- Kootenai River Network
- Missouri River Basin Association
- Montana Agricultural Business Association
- Montana Association of Conservation Districts
- Montana Association of State Grazing Districts
- Montana Chapter American Fisheries Society
- Montana Environmental Information Center
- Montana Farm Bureau Federation
- Montana Farmer's Union
- Montana Grain Growers Association
- Montana League of Women Voters
- Montana Mining Association
- Montana Public Lands Council
- Montana Riparian Association
- Montana River Action Network
- Montana Rural Water Systems
- Montana Salinity Control Association
- Montana State Grange
- Montana Stockgrower's Association
- Montana Water Resources Association
- Montana Weed Control Association
- Montana Wildlife Federation
- Montana Wool Grower's Association
- Montanans Against Toxic Burning
- Nature Conservancy
- Northern Lights Institute
- Northern Plains Resources Council
- Trout Unlimited
- Women Involved in Farm Economics

Water rights education class, Valier, Montana. Photo Courtesy Mary Ellen Wolfe

Starting a Local Watershed Action Group

- Begin with a focused problem or issue.
- Form a diverse planning group.
- Form a technical advisory team.
- Conduct inventories and evaluations.
- Prepare and present list of alternatives at public meetings.
- Approve and adopt plan.
- Implement solutions.
- Review, reevaluate, and update as necessary.

Some Watershed Planning Groups in Montana

- Big Hole Watershed Committee
- Bitterroot Water Forum
- Blackfoot Challenge
- Clark Fork–Pend Oreille Coalition
- Lower Missouri Coordinated Resource Management Program
- Muddy Creek Task Force
- Musselshell River Technical Steering Committee
- Ruby River Task Force
- Smith River Coordinated Resource Management Group
- Upper Clark Fork Steering Committee
- Willow Creek Working Group
- Willow Creek Working GroupThe Big Hole Watershed Committee

Local Health Department

The health departments of city, county and tribal governments are responsible for protecting public health from communicable disease, including water-borne disease that can be transmitted through ground and surface water. They assess potential public health problems, and adopt policies and practices that prevent pollution and clean up contamination. Health departments also enforce public health standards, treat drinking water before human consumption, and treat wastewater after use.

City & County Commissions and Boards

City and county governments offer opportunities for citizens with creative ideas to participate in local water management and planning issues. For example, citizens can join boards, committees, and task forces that create effective policies for local water protection and management. In growing communities, these governmental groups may explore water treatment technologies and land-use alternatives that protect critical water supplies. Constituent concerns also often inspire local governments to pass ordinances that set in motion land-use planning, wetlands protection, and water conservation—work that welcomes your participation.

Conservancy Districts

These formal political subdivisions of the state are formed by public petition and governed by an elected Board of District Directors. A conservancy district can cross county boundaries to manage various water-related activities within a basin, such as flood control and prevention of erosion and sedimentation. It has the authority to adopt rules, assess property taxes, issue bonds, enter into contracts and agreements, and exercise the right of *eminent domain*. As of 1995, the only conservancy district established in Montana manages the Libby Creek drainage.

Conservation Districts

Conservation districts exist in all Montana counties to address local water resource needs. Guided by a locally-elected board of directors, a conservation district assesses special water problems, regulates stream management, and educates citizens about land-use practices and pollution prevention. Collaborative watershed management is addressed through its Capacity-Building Program.

Water Quality Districts

Counties establish local water quality districts to protect, maintain, and improve water quality. To establish a district, the county commission must pass a resolution of intent, and city councils pass a resolution to join the proposed district. A 30-day protest period ensues, and notice is sent to each person who will be required to pay an annual fee. If less than 20 percent of the public registers objections, the county commission may create the district after a public hearing. If 20 percent or more of the public registers objections, the county commission must hold a referendum election allowing voters to approve or disapprove the district.

If the water quality district is approved, a board of directors designs the district's program and submits it for approval to the State of Montana. A typical program involves water quality inventory and monitoring, wellhead protection, pollution prevention, and public education. Districts may administer local ordinances, may be granted enforcement authority, and may also collect fees to fund their activities. Water quality districts exist in Lewis & Clark, Gallatin, and Missoula counties.

Wellhead Protection Program

Wellhead protection programs safeguard public water supplies from contaminants that may pose a health risk. Local programs require creating a community team that oversees the project, maps the ground water supply area, prepares an inventory of the activities that potentially can pollute the water supply, and prepares a protection plan.

Once certified by the State of Montana, a wellhead protection area is given priority for government programs that clean up, control, or prevent pollution. For example, the public water supply may become eligible for waivers from costly monitoring or disinfection regulations.

Water Commissioners

Once the water rights in a basin have been verified by the Montana Water Court, local water users can petition the district court to appoint a water commissioner. This person ensures that daily water activities in the basin occur in accordance with the users' rights. The local district court appoints someone to this position, and oversees the commissioner's work.

Irrigation Districts

Irrigation districts are a subdivision of government that supplies water to irrigators within a specified region. Citizens may establish one by petitioning the court. Members of the district elect a Board of Directors that makes policy, hires managers, and makes management decisions based on legal regulations and self-adopted by-laws. All district members pay taxes to construct and maintain the water project—usually a storage reservoir or canal system—supplying their district. Most federal irrigation projects are managed by irrigation districts.

Water User Association

These non-profit corporations manage mostly state or local irrigation projects. If they manage state-owned projects, they are bound to terms of water-use contracts prepared by the Department of Natural Resources and Conservation. The State of Montana holds the water rights for these projects. If not associated with state-owned projects, water user associations (sometimes called Ditch or Canal Companies) develop their own operating rules. The Middle Creek Water Users' Association is one example of a state-owned project near Bozeman. The Livingston Ditch Association, near Livingston, is not associated with a state-owned project

Model Water Use Agreement

Burnt Fork Experience

Water users on the Burnt Fork, a tributary of the Bitterroot River, used a water use agreement to solve a dilemma. The problem arose when a senior water right holder, who was located near the stream's mouth, demanded delivery of his full amount of water. This demand required that all water normally used upstream by junior water rights be used as *carriage water* to transport his water supply down the length of the stream.

All upstream water users collaboratively developed a creative strategy to increase their water use and decrease the amount of water lost during conveyance. They proposed that the senior water right holder exchange his water right for water delivered by an adjacent irrigation company operating from the Bitterroot River. In return, the upstream users receive the Burnt Fork water in exchange. They facilitate the process by pay ing the irrigation company for water and operation charges. The upsteam users then have the right to divert the exchanged water, upstream, at their private headgates. This means the upstream users actually take possession of the first water right downstream, moving the use of the right upstream and adding it to their present demands.

The exchange benefits water supply for the entire basin. Return flows from the first water right are now available for reuse, and this reuse may now occur several times within the basin. Also, the carriage water is now available for use among the more junior upstream water right holders. This complex exchange is now well-documented in the district court's record.

Ditch or Canal Companies

Local irrigators set up these private companies to share the cost and maintenance of the ditch system serving their collective lands. Ditch companies vary greatly in membership and acreage, and often address the water needs of many individual water right holders.

Creating Solutions

Local and state efforts are bringing a variety of people together to create consensus-based plans that manage conflicting water rights and the many issues of watershed water use.

Water Rights Modifications—Sales, Leases, Exchanges

In areas where local water demands are high, local water users can sell or permanently change water rights. For example, exchanging water rights may be the only method of acquiring future water-use rights in basins closed to new appropriations of water. Such exchanges require administrative review.

Montana Water law also provides the following:

- Salvaged water (water saved through conservation or improved efficiency) may be legally protected and used.
- Water rights may be leased on a limited basis for the creation or enhancement of instream flow.
- A temporary change or transfer of water rights may be made between uses and, potentially, between users.

Water Use Agreements

The most common, but probably least recognized, method of local water management involves individual water users who resolve problems or conflicts among themselves. Current state law does not include procedures to protect or recognize informal local water agreements. Consequently, they may have unforeseen risks, such as unknowingly creating a negative impact on other water users. Informal water use agreements are often formalized by written contract, thus ensuring that their impacts are known and agreed upon by the parties to the agreement.

Water Measurement Program

In 1991, the legislature created a Water Measurement Program to help resolve chronically dewatered stream conditions and conflicts among water right holders. The Department of Natural Resources and Conservation, with other agencies and groups, identifies stream reaches where water supply problems occur. They then depend on local water management and consistent, accurate measurement of diverted water to help them assess the problems and find solutions.

Sustainable Communities Project

Through the Sustainable Communities Project, the Governor's Montana Consensus Council offers a series of training seminars for citizens and communities interested in using consensus to build sustainable communities.

Mediation Options

When local water conflicts arise, mediation can sometimes help resolve the conflict. Mediation engages the parties to a dispute in direct negotiation with one another, with the help of an independent third party. It can have benefits over more costly and time-consuming processes such as lawsuits because settlement costs are usually less, the parties are involved directly in developing the solutions, and they usually accept the solution more easily. In Montana, you can obtain mediation three ways:

- Through its **Water Mediator Program**, the District Court appoints mediators to reconcile water controversies when requested by the Governor's office or by petition from water users. Mediation provides resolution of issues on streams where water rights have never been judicially examined. The Department of Natural Resources and Conservation is responsible for training water mediators.
- The **Montana Water Court** retains a list of mediators with a background in water law, water right issues, and mediation who can help the court and water users settle pre-1973 water rights.
- The **Montana Consensus Council** is a neutral forum designed to resolve complex multi-party natural resource issues. Its goal is to promote long-term, effective processes for building agreement on contentious natural resource policy issues such as water allocation and management, balancing multiple uses of public lands, and maintaining the stability of resource-dependent communities.

Working with State Programs at the Local Level

Local water users' needs and interests sometimes recommend water management strategies that are local, but require state approval and/or participation. These generally include management issues that cross local government boundaries or that become part of state-wide strategies.

State Water Planning

Montana's State Water Plan, coordinated by the Montana Department of Natural Resources and Conservation, is developed through public participation. The process acknowledges that different watersheds or basins use different problem-solving approaches. A Basin Advisory Committee with representatives of all affected water users and interests is formed to direct the process locally. This committee identifies problems and implements effective solutions. Some water resource problems will be resolved within the community; others, such as repair of unsafe dams, may require the involvement of federal and state agencies from outside the basin.

State Wetlands Council

The Montana Wetlands Council is an advisory group whose membership is open to the public, agencies, and interest groups who seek to direct the development and implementation of a Montana wetlands strategy. Its mission is to develop a strategy to enhance Montana wetland resources for present and future generations through the cooperation of public and private interests.

Watershed Coordination Council

This council provides professional expertise, data, and education to local watershed groups. The council is comprised of private organizations and staff from many local, state, and federal natural resource agencies.

Basin Closures

(See following page.)

Basin Closures

As demands grow on Montana's rivers and streams, a trend to "close" stream basins to new water appropriations has evolved. Closures may be conditional and may allow water development only for specific uses, sources of water, or periods of use. They are created through administrative rule-making or legislative action.

Basin closures do not affect existing water rights, but they force widespread acknowledgment of water scarcity in affected basins, which often intensifies local water management activities. Examples of local management efforts catalyzed by basin closures include appointment of water commissioners or mediators, creation of water use agreements or organizations, or development of water measurement plans.

Basin closures can be accomplished by administrative closure, legislative closure, through a negotiated compact involving federal reserved water rights, and by creation of controlled groundwater areas.

Administrative Closures

Local petitioners prompt these closures. The petition must be signed by at least 25 percent or ten of the water users, whichever is less. Petitioners must show one of the following:

- *No unappropriated waters exist in the source of supply.*
- *Issuance of new water rights will adversely affect the rights of other water users.*
- *New uses will interfere with other planned uses of water for which a permit has been issued or water has been reserved*
- *Petitions filed by the Department of Environmental Quality should show that continued issuance of water rights will adversely affect the quality of water, Montana's water quality classification, or a discharge permit holder's ability to satisfy effluent limitations.*

Streams closed by administrative petition:

- ***Grant Creek**, tributary to the Clark Fork of the Columbia*
- ***Rock Creek**, a tributary of the Clarks Fork of the Yellowstone River*
- ***Walker Creek**, a tributary of the Whitefish River*
- ***Towhead Gulch**, a tributary of the Missouri River at Holter Lake*
- ***Portions of the Musselshell River***
- ***Sharrot and Willow Creeks**, tributaries of the Bitterroot River*
- ***Truman Creek**, a tributary of the Flathead River (effective February 10, 1995)*

Closures are also pending, as of this writing, for:

- ***Houle Creek**, a tributary of the Clark Fork of the Columbia River*
- ***Six Mile Creek**, also a tributary of the Clark Fork of the Columbia.*

Compact Closures

Two compacts negotiated between the State of Montana and the federal government clarifying the extent of federal and tribal reserved water rights in Montana include basin closures.

- *The **Northern Cheyenne-Montana Compact** imposed a moratorium on water use in Rosebud Creek*
- *The **National Park Service-Montana Compact** instituted basin closures in several different basins to protect federal water rights for the Big Hole Battlefield National Monument, Glacier National Park, and Yellowstone National Park*

Legislative Closures

This type of closure creates an opportunity to examine or establish management alternatives in problem watersheds. The closures include:

- *Permanent closure of the **Milk River** and its southern tributaries in Toole and Liberty Counties.*
- *Temporary closure of the **Beaverhead and Red Rock rivers**, from September 1, 1991 to June 30, 1996.*
- *Temporary closure of the **Clark Fork of the Columbia River** beginning at the Big Blackfoot and Clark Fork rivers' confluence. This closure is in conjunction with a basin management planning effort for the same area.*
- *The **Teton River Basin**, closed permanently to surface water appropriations not relying on high spring runoff.*
- *Temporary closure of the **upper Missouri River and all tributaries**, from the headwaters to Morony Dam just downstream of Great Falls, until the water rights in the basin are verified by the Montana Water court.*
- *Permanent closure of the **Madison and Jefferson rivers** and their **tributaries** in the upper Missouri, from surface water sources not relying on storage of spring runoff*

Controlled Ground Water Areas

The Board of Natural Resources designates this type of basin closure after a petition by at least 20 or one-fourth of the ground water users, whichever is less. Petitioners must show one of the following:

- *Ground water withdrawals are in excess of recharge to the aquifer*
- *Excessive ground water withdrawals are very likely to occur in the near future.*
- *Significant disputes exist within the area concerning priority or amounts of water being used*
- *Ground water levels are declining.*
- *Withdrawals could adversely affecting ground water quality.*
- *Water quality within the ground water area is not suited for a specific beneficial use*

Five areas are designated as controlled ground water areas.

- ***South Pine Controlled Groundwater Area** located in portions of Prairie, Wibaux, and Fallon Counties.*
- ***Larson Creek Controlled Groundwater Area** a small area in Ravalli County near Stevensville*
- ***Yellowstone Controlled Groundwater Area** closed as part of the National Park Service-Montana Compact*
- ***ARCO's Warm Springs Ponds** near Anaconda (effective May 25, 1995)*
- ***Hayes Creek Controlled Groundwater Area**, in the Bitterroot, is permanent in subdivisions (effective May 25, 1995).*

What Does The Future Hold?

As more citizens work together to address problems at the local level, win-win solutions become increasingly possible. Some themes and trends have become apparent:

- Effective problem solving is occurring at the local level among those who are impacted directly by water problems.
- As population growth places pressure on limited water supplies, more programs are being established to educate citizens about water quality, conservation, and pollution.
- Dam operators are negotiating with all affected parties to stabilize flows and to meet a large mix of water uses.
- Buying and selling water on the open market provides one possible solution to solve water resource problems.
- Accurate and efficient water measurement programs are helping to improve water availability during water shortages.
- Best management practices—sound pesticide use, wellhead protection, careful road construction, streamside protection, erosion control reclamation—effectively control or reduce point and nonpoint source pollution.

Your involvement in these efforts is crucial. If you know of a water problem that doesn't seem to be addressed, mobilize local support and search for answers. Sponsor public water awareness and education meetings in your river basin. Get involved in local problem-solving. Become a local land manager—and assure Montana's high quality water, environment, and lifestyle.

For More Information

- Contact:
  - —assisting agencies and groups listed in Chapter Six.
  - —The Montana Department of Natural Resources and Conservation for information on closures, water measurement, water rights adjudication, state water planning.
  - —The Montana Department of Environmental Quality for information on Wetlands Council, Wellhead Protection Program, Water Quality Districts
  - —The Montana Watercourse for information on "Know Your Watershed" workshops
- *Who Does What With Montana's Water? A Directory*. 1994. The Montana University System Water Center.
- *A Catalog of Water Conservation Resources*. 1994. The Montana Watercourse, MSU–Bozeman.
- *Montana Environmental Law Handbook*. 1992. The Law Firm of Crowley, Haughey, Hanson, Toole, and Dietrich.
- *A Landowner's Guide to Western Water Rights. 1994*. The Montana Watercourse, MSU–Bozeman.
- *A Guide to Stream Permitting in Montana*. The Montana Association of Conservation Districts.
- *Tips on Land & Water Management for Small Farms & Ranches in Montana*. 1995. Conservation Districts Bureau, Department of Natural Resources and Conservation.

Simple Ways to Involve Yourself

- Understand how you contribute to nonpoint pollution.
- Ask agencies to make water regulations more understandable.
- Conserve water.
- Sponsor public water awareness and education meetings in your river basin.
- Attend hearings affecting the water future of your town and make recommendations to your decision-making boards and commissions. Become a member of a board or commission.
- If you have a concern that doesn't seem to be addressed, mobilize local support for your own watershed group and search for answers.
- Get involved in local problem-solving. Try one of the methods listed in this chapter!

References and Sources of Information

Anderson, Bob. 1988. "Indian Reservations and Tribes of the Missouri River Basin." In *Boundaries Carved in Water.* The Missouri River Brief Series, no. 11. Missoula, Montana: Northern Lights Institute.

Bonneville Power Administration and Northwest Power Planning Council. 1988. *Pacific Northwest Rivers Study; Final Report: Montana.* Helena, Montana: Montana Department of Fish Wildlife and Parks.

Chittenden, Hiram M. 1903. *History of Early Steamboat Navigation on the Missouri River: Life and Adventures of Joseph LaBarge.* New York: F.P. Harper.

Earll, F. N., editor. 1976. *Handbook for Small Mining Enterprises.* Montana Bureau of Mines and Geology. Bulletin #99.

Governor's Ground Water Advisory Council. 1985. *An Evaluation of Montana's Ground Water Policies and Programs.* Helena, Montana.

Hamilton, James McClellan. 1970. *History of Montana: From Wilderness to Statehood.* Portland, Oregon: Binfords and Mort.

Hilander, Sally, editor. 1988. "Here's to the Rivers: Part One" *Montana Outdoors* 19 (3): 19-30. Helena, Montana: Montana Department of Fish, Wildlife and Parks.

—1988. "Here's to the Rivers: Part Two" *Montana Outdoors* 19 (4): 17-32. Montana Department of Fish, Wildlife and Parks: Helena, Montana. 1988.

Howard, Stanley. 1992. *Greenfields of Montana: A Brief History of Irrigation.* Manhattan, Kansas: Sunflower University Press.

Johnson, Howard, E. and Carole L. Schmidt. 1988. *Clark Fork Basin Project: Status Report and Action Plan.* Helena, Montana: Office of the Governor.

Lopach, James, editor. 1983. *We the People of Montana: The Workings of a Popular Government.* Missoula, Montana: Mountain Press.

Malone, Michael and Richard B. Roeder. 1976. *Montana: A History of Two Centuries.* Seattle: University of Washington Press.

Missoula County Conservation District. 1991. *The Clark Fork Watershed Education Program.* Missoula, Montana.

Missouri Basin Inter-Agency Committee. 1969. *Comprehensive Framework Study: Missouri River Basin* Washington, D.C.

Montana Department of Agriculture and Montana State University Extension Service. 1994. *Montana General Agricultural Chemical Ground Water Management Plan: Strategies to Protect Ground Water From Agricultural Chemicals Through Education and Information.* Technical Document 94-01. Helena, Montana.

Montana Department of Health and Environmental Sciences. 1994. *Montana Water Quality 1994. The Montana 305(b) Report.* Helena, Montana.

Montana Department of Natural Resources and Conservation. 1976. *The Framework Report,* Vol. 1. Helena, Montana.

- —1981. *Issues in Water Management: An Evaluation of Montana's Water Policy.* Helena, Montana.—1982. *A Water Protection Strategy for Montana: Missouri River Basin.* Helena, Montana.
- —1985. *Montana's Water Planning Program: A Report to the Forty-Ninth Session of the Montana Legislature.* Helena, Montana.
- —1986. *Montana Water Use in 1980.* Helena, Montana.
- —1988. *Upper Clark Fork Basin Water Reservation Applications: Draft Environmental Impact Statement.* Helena, Montana.

Montana Environmental Quality Council. 1985. *Montana's Water.* Annual Report, 9th edition. Helena, Montana.

—1987. *Research Topics.* Annual Report, 10th edition. Helena, Montana.

Montana Historical Society. 1976. *Not in Precious Metals Alone: A Manuscript History of Montana.* Helena, Montana: Montana Historical Society.

Montana Office of Public Instruction. 1992. *Montana Indians: Their History and Location.* Helena, Montana

Montana State University Extension Service. 1994. *Water Quality: A Matter of Choice.* Item Number EB0048. Bozeman, Montana: MSU.

Montana Watercourse. 1991. *For the Sake of the Creek: Land and Water Use in the Rock Creek Basin and the Effort to Preserve the Resource.* Helena, Montana: Rock Creek Advisory Council.

National Geographic Society. 1993. "Water: The Power, Promise, and Turmoil of North America's Fresh Water" *National Geographic Magazine,* Special Edition. Washington, DC.

Rodriguez, Denise. 1980. *1980 Profile of the Montana Native American.* Helena, Montana: Office of the Coordinator of Indian Affairs.

Spence, Clark C. 1978. *Montana: A Bicentennial History.* New York: Norton Co.

U. S. Environmental Protection Agency, Region 10. 1993. *Clark Fork-Pend Oreille Basin Water Quality Study: A Summary of Findings and a Management Plan.* Seattle, Washington: EPA.

U.S. Bureau of Mines. 1977. *Mining and Minerals Operations in the Rocky Mountain States.* #024-004-01899-2. Washington, DC: Government Printing Office.

U.S. Geological Survey. 1986. "Montana Surface Water Resources" In National *Water Summary 1985-Hydrologic Events and Surface-Water Resources.* Water Supply Paper 2300; pages 309-314. Washington, DC: Government Printing Office.

Water Policy Committee, Montana State Legislature. 1986. *Report of the Water Policy Committee to the 50th Legislature of the State of Montana.* Helena, Montana: Environmental Quality Council.

Glossary

acre-foot—The amount of water that covers one acre to a depth of one foot. It equals 43,560 cubic feet, or 325,851 gallons.

advanced treatment—Often not require, this is the third phase of wastewater treatment which removes most nutrients remaining after primary and secondary treatment.

alluvium—Unconsolidated material such as silt, sand, or clay that has been deposited by a stream; alluvial refers to streamside sediments.

appropriate—To take for one's own use; in the case of water it is to divert, impound, or withdraw a quantity of water.

aquifer—An underground bed of saturated soil or rock that yields significant quantities of water.

basin closure—The legal termination, either temporary or permanent, of the issuance of water rights in an entire river basin, or upstream of a designated location in a river basin.

bedrock—A general term for the rock that underlies soil or other unconsolidated materials.

beneficial use—The use of water for the benefit of the appropriator, other persons, or the public, including but not limited to agricultural, domestic, fish and wildlife, industrial, irrigation, mining, municipal, power, and recreational uses.

best management practice—Methods adopted by resource users to mitigate harm to the environment.

biological integrity—The ability of an aquatic ecosystem to support and maintain a natural plant and animal community. It is compromised by pollution, habitat modification, or the introduction of exotic species.

blue ribbon stream—One of twelve high quality trout streams in Montana designated by a Murphy instream flow designation.

compact—A formal agreement approved by the participating states and Congress.

consumptive use—The use of a resource that reduces supply (such as removing water from a source such as a river or lake without returning an equal amount.) Examples of consumptive use are: intake of water by plants and animals, and the incorporation of water into industrial byproducts.

dewatering—The action of diverting water from stream so that much of the water resource is depleted.

discharge—An outflow of water from a stream, ground water system, pipe, or watershed.

effluent—A waste liquid discharge from a manufacturing or treatment process into the environment.

eminent domain—The right of a government to take, or authorize the taking of, private property for public use, with just compensation being given to the owner.

eutrophication—A process affecting waters that are rich in mineral and organic nutrients, whereby plant life proliferates, eventually reducing the dissolved oxygen content and often killing off other organisms.

ground water—Water in porous materials beneath the ground surface.

habitat—The environment where a plant or animal grows or lives.

habitat modification—Activities that destroy the integrity of an aquatic or terrestrial ecosystem. In a aquatic system, habitat modification causes changes in streamflows, lake levels, and water temperature. Habitat modification promotes nuisance plant growth and generates byproducts that make water unfit for use and more expensive to treat.

headwaters—The source of a stream.

instream flow—Water in streams or rivers that is used for nonconsumptive purposes such as the preservation and enhancement of fish, recreation, wildlife, and water supply.

intermittent stream—A stream that has flowing water only part of the year.

multipurpose reservoir—Reservoirs constructed for a combination of purposes, including hydroelectric power generation, flood control, storage for irrigation, and recreation.

Murphy right—Special instream flow water rights recognized in 1969 when an instream flow protection bill was passed by the Montana legislature to protect the unappropriated waters of 12 high-priority trout streams.

negotiated agreement—A commitment to seek and be bound by a mutually-accepted agreement, through negotiation. Negotiated agreements are often used to quantify reserved water rights on federal and Native American lands.

nonconsumptive use—The use of a resource that does not decrease the supply, flow or level. Examples of nonconsumptive water use include canoeing, hydropower production, and fish spawning.

nonpoint source pollution—A release of contaminants originating from activities over a broad area of land.

offstream flow—Water that is diverted or used away from its source.

perennial stream—A stream which flow year-round.

physiographic—A description of the features of physical geography.

placer gold—Gold mined from deposits of glacial sand and gravel which have been eroded from their original bedrock and concentrated as small particles that can be washed out.

point source pollution—Pollutants discharged from an identifiable point including pipes, ditches, channels, sewers, and tunnels.

primary treatment—The first phase of the wastewater treatment process, this phase removes large materials and particles that have settled out.

prior appropriation doctrine—The primary Western water rights doctrine that is based on the principle "first in time, first in right." The doctrine requires the water user to show an intent to appropriate water and divert it to a beneficial use.

recharge—The addition of water to rivers or aquifers which tends to raise the water table.

reserved water rights—A right to use water that is implied when the federal government reserves land from the public domain by an Act of congress, a treaty, or an executive order. A reserved water right may also be created by explicit direction of Congress in federal statutes.

return flow—That portion of water diverted from a source which returns to the system unconsumed, often further downstream.

riparian—Areas directly influenced by a body of water with vegetation indicating this aquatic influence.

river basin—See watershed. The area from which water drains to a single point; in a natural basin the area contributing flow to a given point in a stream.

secondary treatment—The second phase of the wastewater treatment process. It converts the remaining dissolved and suspended biodegradable organic wastes into a settleable sludge using microorganisms. Commonly, this stage includes trickling filters, activated sludge, and clarification, often followed by disinfection (ultraviolet or chlorination).

self-supply—A supply of water that does not originate from a public source, such as municipal supply. Many industries are self-supplied and are required to obtain a water right.

surface water—Water on or above the surface of the land, including lakes, rivers, streams, ponds, flood water, and runoff.

transmissivity—The rate at which water is transmitted through an aquifer.

wastewater—Water that is returned for treatment after its use.

water reservation—A water right granted by the Board of Natural Resources to public entities, on behalf of the public, for existing or future beneficial uses, or to maintain a minimum flow, level, or quality of water.

water right—A legal right to use a specified amount of water for beneficial purposes.

watershed—A geographic area that includes all land and water within the confines of a drainage divide. It contains a common outlet into which water, sediments, and dissolved materials from the land flow. Watersheds can be as small as a backyard or as large as the Mississippi River watershed.

well yield—The volume of water discharged from a well in gallons per minute or cubic meters per day.

wetland—A landform characterized by the presence of water, hydric soils, and water loving vegetation. Wetlands often form the transition zones between uplands and deep water environments.

whirling disease—A fish disease recently detected in trout populations in various Montana rivers. The disease is caused by a natural parasite which weakens and kills trout and some other fish species. It was first detected in the Madison River.

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About The Montana Watercourse

The Montana Watercourse is a statewide adult and youth water education program created in 1989 at Montana State University, Bozeman. Its goals are to promote awareness, create new knowledge, and build informed participation in Montana's water management processes. Watercourse programs include:

- ✗ *An Adult and Community Water Awareness Program, providing citizens with information and educational forums on critical water resource topics.*
- ✗ *Project WET Montana, a Water Education for Teachers program, providing school teachers and other educators with innovative teaching materials and activities to advance children's understanding of Montana's water resources.*

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